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PRESENT STATE OF THE INTRACAPSULAR CATARACT OPERATION

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THE IDEA of removing the cataract in its capsule has interested ophthalmic surgeons for many years, but it was not until Henry Smith, in 1903, accepted the opportunity, offered by the many sufferers from cataract in India, to develop an intracapsular technic that a new era began in cataract surgery. While the advantages of removing the capsule and the lens cortex in the cataract operation were apparent to every one, the difficulties and complications of this new procedure were soon recognized, and attempts to overcome them became the task of an ever increasing number of operators.

The success of these attempts has been most encouraging; the intracapsular operation has gained steadily in favor and is now practiced by an increasing number of surgeons. An analysis of these efforts and a critical examination of the intracapsular operation of the present day are the purpose of this address.

The history of the intracapsular cataract extraction goes back many years. At the Amsterdam Congress, in 1929, Marquez spoke of a book published in 1789 in which the intracapsular extraction with forceps was described.[1] About 1850, McNamara, of Calcutta, practiced a method of intracapsular extraction by combined external pressure applied just back of the incision with the curet and at the opposite limbus with the tip of the finger; and Wright, of Columbus, Ohio, described a similar method at about the same time.

The two Pagenstechers[2] stated their belief that the remaining capsule and remnants of the lens in the usual cataract extraction were the principal causes of iritis and practiced a method of removing the lens in its capsule by introducing a spoon back of the lens and extracting

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1. Pellier de Quengsy: Précis du cours d'opérations sur la chirurgie des yeux, Paris, Didot & Mequignon, 1789-1790.

2. Pagenstecher, A.: Klinische Beobachtungen aus der Augenheilanstalt zu Wiesbaden, Wiesbaden, J. Niedner, 1866.

the lens, with the loss of a few drops of vitreous. De Wecker [3] operated in 66 cases and then abandoned the procedure. Terson, in 1872 and 1887, reported that he extracted the cataract by applying external pressure after grasping the capsule of the lens with a special forceps. Molroney, of India, in 1894, practiced a method similar to McNamara's.

According to Smith,[4] the intracapsular method would have been lost with Molroney, as he never wrote on the subject, if someone else had not come on the scene. Smith was led to try intracapsular extraction after he had observed in operations on nervous patients under cocaine anesthesia that occasionally, on completion of the incision, the patient, in screwing up the orbicularis muscle, shot out both the lens in its capsule and a quantity of vitreous. To his agreeable surprise, the results in these operations were generally good. In 1903, Smith [5] published a report of 6,500 intracapsular operations, and the era of the intracapsular extraction began.

But the operation of extracting the cataract in the capsule by external pressure alone did not find many followers because of complications, of which loss of vitreous was the principal factor, and other attempts to obtain the same results were soon made. These consisted in grasping the anterior capsule either with the forceps or by means of a suction apparatus.

The first step in the intracapsular extraction was the subluxation of the cataractous lens by rupture of the zonular fibers which support the lens. In this step two structures were encountered, namely, the zonule and the capsule.

ANATOMIC RELATIONS

Ciliary Zonule.—Three anatomic features of the zonule are important in this connection: (1) the origin of the fibers, (2) the independence of the zonular membrane of the hyaloid part of the vitreous and (3) the insertion of the zonular fibers into the capsule of the lens. The zonular fibers arise from the pigment epithelium and the plane portion of the ciliary part of the retina. They are cemented together by a translucent substance to form the ciliary zonule, or suspensory ligament and pass across the perilenticular space to divide into two leaves, which become attached, respectively, to the anterior and the posterior capsule of the lens. In addition, some fibers are attached to the equator of the lens, but they are not strong and hence do not play any role in the intracapsular extraction. Though the zonule fits into the curved surface of the posterior third of the ciliary processes, it is independent and can be easily detached without injury to the pigment cells, except where

3. de Wecker: Traité théorique et pratique des maladies des yeux, ed. 2, Paris, A. Delahaye, 1866-1867, p. 22.

4. Smith, H.: The Treatment of Cataract and Some Other Common Ocular Affections, London, Butterworth & Company, 1928, p. 209.

5. Smith, H.: Extraction of Cataract in the Capsule, Brit. M. J. **2**:719, 1903.

it becomes firmly united to the ciliary portion of the retina; then large pieces of retinal epithelium are pulled off in its separation.

On its internal surface the zonule is in contact with the hyaloid membrane of the vitreous body, but it is quite independent, as they are two different structures. The hyaloid membrane comes in contact with the ciliary crests through the intermediary role of the zonule and passes like a bridge over the valleys. At the plane portion the zonule separates the hyaloid membrane from the retina, while at the ora serrata the retinal epithelium and the hyaloid are united. The ciliary processes are in contact with the suspensory ligament only in their posterior portion. Hence, total extraction has no deleterious action, as rupture of the fibers takes place close to their capsular insertion.

Beauvieux found that the fibers were torn at the level of the walls of the canal of Hannover and that therefore some very short zonular fringes remained, with or without tearing a portion of the zonular layer of the lens capsule.

The zonule becomes friable with advancing years, and the readiness of its rupture is proportional to the age of the patient; up to a certain age the zonule retains its elasticity, and rupture does not occur readily.

Lens Capsule.—The capsule of the lens is a clear structureless membrane, which is thicker in its anterior than in its posterior layer. The thickness of the capsule varies in different parts of the lens.[6] On both the anterior and the posterior surface there is a circular zone of maximal thickness running concentrically with the equator a short distance axial to the insertion of the zonular fibers. The thickest part anteriorly is in a region 3 mm. distant from the anterior pole, while the thinnest part is at the exact center. There is an adhesion between the posterior layer of the capsule and the vitreous in the form of a ring 8 to 9 mm. in diameter; this is known as the hyaloid-capsular ligament and is extremely thin.

Though it is generally easy to remove the lens from its hyaloid (patellar) fossa, I have found sometimes at operation that an adhesion was present. The fibers of the suspensory ligament are inserted into the zonular layer of the capsule, in a zone concentric with and at a short distance from the equator on the anterior and the posterior surface. The zone of insertion is broader on the anterior surface than on the posterior surface, in the ratio of 3 to 2, and with advancing years there is a gradual increase in thickness of the capsule throughout.

It is natural that the more elastic the capsule the more difficult it is to rupture. Though the thinnest part of the capsule is at the posterior pole, rupture at this place seems to be infrequent.[7] It is well known

6. Duke-Elder, W. S.: Text-Book of Ophthalmology, St. Louis, C. V. Mosby Company, 1932, vol. 1, p. 132.

7. Rötth, A., and Klein, N.: Die Linsenkapsel bei der intrakapsulären Staroperation, Klin. Monatsbl. f. Augenh. **84**:823, 1930.

that after iridocyclitis the capsule thickens, and at operation it can be easily grasped and the cataract extracted in its capsule. In fact, this form of intracapsular extraction antedated the time when the intracapsular extraction was done for the usual senile cataract.

Other peculiarities of the capsule depend on the consistency of the cataract, which plays an important role from an operative standpoint, and an important one of these is the tenseness of the capsule. If the capsule is tense, it is impossible to grasp it; the forceps slips off, and if a hold is obtained the capsule is apt to rupture; this tenseness of the capsule occurs in the cases of swollen cataract and of the hard cataract in which the nucleus lies directly under the capsule.

The lens and its suspensory ligament are in contact only with the vitreous body, and the vitreous body is adherent to the underlying structure only in the region of the ora serrata. Hence, it is explainable how easily the lens can be removed in its entirety without fearing loss of vitreous. In anatomic dissections the hyaloid membrane is separated with great facility from the posterior zonular membrane. In fact, anatomists described a potential space (Petit's space) between the posterior zonular membrane and the hyaloid membrane which sometimes contained blood or inflammatory products.

Beauvieux [8] repeatedly attempted to extract the crystalline lens and its capsule in enucleated eyes by the posterior surface and was surprised to observe that unusual resistance existed. On the other hand, gentle and continuous traction on the anterior surface of the lens resulted in rupture of the zonular fibers without requiring a great deal of effort.

Troncoso,[9] in 1936, recommended the anatomic method of examination with the slit lamp microscope for a stereoscopic view of the architecture of the zonule and of the surrounding tissues in specimens stained with Flemming's solution. The dissection was made under water, as this in no way disturbed the position and relation of the various tissues.

Goldsmith [10] examined microscopically 2 eyes that had undergone the intracapsular operation and found no evidence of a tear of the hyaloid membrane or of any traumatism to the ciliary epithelium, thus substantiating Verhoeff's [11] observations.

In an anatomic examination of 50 human eyes obtained shortly after death, Goldsmith found that the vitreous body was easily detached

8. Beauvieux: La zonule, Arch. d'opht. **39**:410, 1922.

9. Troncoso, M. U., in discussion on Goldsmith,[10] p. 430; Intrascleral Vascular Plexus and Its Relation to Aqueous Outflow, Am. J. Ophth. **25**:1153, 1942.

10. Goldsmith, J.: Dynamics of Intracapsular Cataract Extraction: Experimental Studies with Reference to Suspensory Ligament, Hannover's Canal and Petit's Space, Arch. Ophth. **29**:380 (March) 1943.

11. Verhoeff, F. H.: Conditions of the Ocular Structures Immediately After Removal of the Lens in Capsule as Determined by Microscopic Examination, Tr. Am. Ophth. Soc. **29**:184, 1931.

from the posterior zonular membrane and from the posterior surface of the lens but that a slight resistance was encountered at the retroequatorial region of the lens. After section of the suspensory ligament, the attempt to draw the lens forward met with decided resistance, and the separation occurred slowly; but if the attempt was made to deliver the lens tangentially the separation succeeded easily, and after extraction a large depression was noted, which corresponded to the hyaloid fossa. This confirms the experience of intracapsular operators that the lens cannot be drawn forward from the hyaloid fossa but that it can more easily be dislodged tangentially. This has led to the practice of side to side movements of the lens in the subluxation maneuver of the forceps operation.

STEPS IN THE INTRACAPSULAR OPERATION

The primary step in the intracapsular operation is the subluxation of the lens by rupture of the suspensory ligament. The facility of this rupture depends on the state of the suspensory ligament and of the capsule of the lens, and it may be said that the success of the intracapsular extraction rests on two factors: the capsule of the lens and the zonular fibers and on their relation.[12] The capsule thickens up to the age of 35 to 40 years, and the resistance of the zonular fibers is reduced with age, though there may be individual differences. The adhesion between the capsule of the lens and the hyaloid membrane loosens as the vitreous body retracts with age (Arruga). The weakest point of the zonular fibers is at the capsular insertion. In the capsule, thickness, tenseness and elasticity are important; and, as has been mentioned, the capsule is thickest in an area between the equator and the poles; at the poles it is thin.

The clinical varieties of the cataract are also of moment in the process of subluxation, and extraction is easiest in the case of the sclerosed lens and of the soft mature or nearly mature cortical cataract; less favorable are the hard, the large nuclear and the hypermature cataract. Least favorable is the intumescent cataract. The most important changes in the zonule and in the capsule are due to age and are exemplified in their most extreme stage in the frequent dislocation of the morgagnian cataract; on the other hand, the elasticity of the suspensory ligament in the young resists all reasonable attempts at dislocation.

In short, the older the patient, the easier the subluxation; hence, intracapsular extraction is not suitable for young patients, and that means, generally speaking, persons under 45 years of age. The capsule in the intumescent, or immature, stage of the nonsclerosed type of

12. Rötth, A.: Ueber die anatomischen Grundlagen der kapsulären Kataraktextraktion, Orvosi hetil. **11**:1238, 1930; abstracted, Zentralbl. f. d. ges. Ophth. **25**:59, 1931.

cataract is tense and thin and is liable to rupture during the attempt at subluxation.

Attempts have been made to determine with the slit lamp the suitability of a cataract for intracapsular operation, and Rohrschneider [18] stated that the presence of water clefts makes the cataract unsuitable for the intracapsular operation in a large proportion of cases and that the nuclear and posterior cortical varieties are all suitable for this operation, as well as those with subcapsular vacuoles and coronaria opacities. The most important point is the patient's age, and the best results are in persons over 60 years of age.

Meissner expressed the opinion that cataracts complicated with old iritis were particularly suitable for the intracapsular extraction and suggested that an iridectomy be first done and the adhesions separated, while Smith and Stock did not think it necessary to separate the adhesions. While knowledge of the friability of the zonule and the thickness of the capsule would be of advantage to the operator, there is at present no way, by examination with the slit lamp or by any other means, to obtain this information.

A number of ways have been devised to effect subluxation. The first was that of Henry Smith, which consisted in external pressure on the eyeball. Pressure exerted straight back on the lower half of the cornea caused the head of the lens to present, while pressure in the lowest periphery, in a downward direction, caused the lens to somersault. Thus, Smith devised two methods of subluxation according to the consistency of the cataract; and, from an operative standpoint, he divided cataracts into hard and soft.

The attachment of the suspensory ligament was weaker in the soft than in the hard types; in both types the attachment weakened with advance of the patient's age. The upright delivery was applicable only to hard cataracts. Pressure was applied straight back in the lower third of the lens with a small tenotomy hook applied flat, by which means, when pressure was exerted with the elbow of the hook, the intraocular pressure was raised and the ligament was ruptured by pressure with the tip of the instrument.

With the second, or soft, variety the head-first delivery was easier, but the capsule ruptured too frequently. This was avoided by exerting pressure with the hook downward, as though trying to pull the patient's eye toward his feet; the lens rolled upward, becoming dislocated at the lower edge first, and then, as a result of following up the turning movement with the tip of the hook, the lens was delivered "feet first" and its attachment above was finally peeled off.

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13. Rohrschneider, W.: Die Virwirtung der Spatlampenbefundes an der Linse bei der Indikationsstellung zur intrakapsulären Extraktion, Ber. ü. d. Versamml. d. deutsch. ophth. Gesellsch. **53**:182, 1940.

Smith laid down the fundamental rule, applicable to all methods, that the lens must be made to swing round on a transverse axis, so as to concentrate the strain on the suspensory ligament at one or two points. When the ligament gave way at this point and the lens was dislocated from the hyaloid fossa, then, and then only, could the lens be removed from the eye.

The Smith method of subluxation of the cataract by external pressure alone requires great delicacy, lightness of hand and dexterity. As these attributes are not common to all operators, other methods of subluxation have been suggested.

The first of these to be considered is the principle of suction, by which a hold on the anterior capsule is taken with a cup-shaped device. The Hulen apparatus did not gain recognition, and the principle was forgotten until Barraquer [14] devised an apparatus which consisted of an electrically driven pump, a most ingeniously designed instrument, and a suction cup. The cup is applied to the capsule of the lens, which is bruskly contracted by suction through the pump action, and the zonular fibers are ruptured as the cannula is rotated in the arc of the incision, without traction on the ciliary body. The cataract is then lifted out of the hyaloid fossa, by turning the handle on its axis, without deforming the vitreous, and is withdrawn from the anterior chamber either by suction or by slight pressure on the cornea. The section need not be larger than in the ordinary operation, i. e., two fifths of the corneal circumference. The iridectomy must be peripheral but large enough to prevent prolapse. The intensity of the vacuum can be regulated, but it is important that the cup close firmly and that the mechanical action of the pump be carefully looked after.

The technic of applying suction with the cup is delicate and difficult. If the intensity of the vacuum is too great, the capsule ruptures; if too little, the apparatus slips from the cataract. The extraction is performed either head first or by tumbling; the latter technic is better and involves fewer accidents. Complications are due to poor application of the cup, to an incorrect gage or to the wrong choice of diameter of the cup. Accidents are avoided by causing the superior border of the cataract to glide exactly in the curvature of the hyaloid fossa, without exerting any pressure. It is important that the suction cup be of suitable size and that the lens first be dislocated into the anterior chamber before extraction is attempted.

The Barraquer procedure was objected to because the electric pump was found too complicated. In my hands, the pump's action was not

14. Barraquer, I.: (*a*) La suture cornéo-sclérale dans l'extraction totale de la cataracte sénile, Ann. d'ocul. **176**:470, 1939; (*b*) Dangers of Capsulotomy and Advantages of Complete Extraction, Arch. Ophth. **50**:307, 1921.

easily controlled and therefore became dangerous. The Greens have simplified the principle of the pump. Though the suction cup takes hold of some capsules better than other means, the procedure has not been generally adopted.

Some authors have replaced the Barraquer apparatus with a glass syringe with a special cup (Argañaraz [15]). The zonular fibers are torn tangentially by moving the syringe from one end of the incision to the other; then lateral and anterior movements are added, and finally the extraction of the lens occurs, after a rotation of 180 degrees.

On the occasion of a visit to Colonel Smith, in Jullunder, India, in 1908, I was impressed with the greater safety of the tumbling maneuver as compared with the head-first extraction. On returning home, my efforts with the Indian technic were not satisfactory, as I failed to subluxate the cataract with the amount of manipulation which I thought was justifiable; and I returned to the capsulotomy procedure.

On using the Kalt forceps, which was devised by its author for capsulotomy and is constructed like a bifurcated cup, with blunt edges and branches, bent on the model of a Terson toothed-capsule forceps, I found that, with a little care, the lens could be subluxated at one point without tearing the capsule. The anterior capsule was grasped under the iris in the lower third, and, after manipulation, subluxation took place below. When this subluxation of the lens had taken place, and the lower margin of the cataract appeared in the pupillary area, fearing that further traction with the forceps would tear the capsule, I released the capsule forceps.

Pressure straight back was then applied at the lower corneal margin with Smith's blunt tenotomy hook, and, with counterpressure above at the scleral edge of the incision, the lens in its capsule was made to tumble; with continued pressure below, and directed partly upward, the lower margin of the lens traversed the anterior chamber and presented in the section. After delivery of the equator, the lens was easily extracted by separating the adhering suspensory attachment above. I performed the first operation according to this technic in February 1910.

A report by Stanculeanu was made in August 1910, at the Heidelberg meeting of the German Ophthalmological Society, describing a similar method of intracapsular extraction with the Manolescu forceps, but no details of the operation or results were given until Stanculeanu's [16] article appeared, in 1912, describing his method. He used the reverse sides of a blunt-tipped iris forceps and grasped as large a fold of capsule as possible. Then, with lateral movements and some traction

15. Argañaraz, R.: La extraccion de la cataracta senil par medio de la ventosa a mano; vacuo avulsion o facoerisis, Arch. de oftal. de Buenos Aires **12**:609, 1937.

16. Stanculeanu, G.: Intrakapsuläre Staroperationen, Klin. Monatsbl. f. Augenh. **50**:527, 1912.

upward, the lens with its capsule was separated from the zonule. When this occurred, the forceps was released. Pressure with two spatulas in the usual manner brought about the extraction. This resembled the procedure which I followed except that with my method stress was laid on avoiding a head-on delivery by grasping the capsule as low as possible, so as to subluxate the lens below, and then tumbling the lens.

Descriptions of various intracapsular procedures then began to make their appearance in ophthalmologic literature, with lessening attention to the Indian method of extraction by external pressure and with increasing interest in the forceps extraction.

Török,[17] who at that time was connected with the Herman Knapp Memorial Eye Hospital modified the forceps extraction by grasping the capsule in its upper half with the Kalt forceps and, with pressure exerted below, expressed the lens head first, the forceps keeping hold of the capsule throughout the extraction. Verhoeff found that the expression of the cataract was facilitated by the addition of external pressure. Smith had always drawn attention to the importance of external pressure, by which the tension of the vitreous was increased and subluxation of the cataract facilitated.

I have gone over Török's cases in the hospital records, with his permission and have found that during a similar interval of time with his procedure the number of ruptures of the capsule during the process of delivery was 12 per cent, while in my series it was 6 per cent. Rupture of the capsule during delivery is an unpleasant complication, as it requires the removal of the capsular bag separately, which is often difficult, especially in the presence of escape of vitreous.

Verhoeff is opposed to tumbling, as it deforms the vitreous. De Grôsz [18] expressed the belief that with the tumbling of the lens loss of vitreous is more frequent, that there are more instances of expulsive hemorrhage and that in after years the pupil becomes distorted; he expressed preference for the head-on delivery, as it is easier and simpler.

While I personally prefer the process of tumbling, as it is the safer method, the addition of external pressure has succeeded in dislocating a larger percentage of cataracts. This has led to the adoption of the following procedure: The lens capsule is grasped at its lowest part; moderate traction is exerted in various directions, with simultaneous external pressure with the Smith hook at the inferior margin of the cornea until dislocation below has taken place and the lower margin of the cataract appears in the pupil; this is followed by release of the forceps and extraction of the partly subluxated lens, by external pressure,

17. Török, E.: Extraction of Cataract in the Capsule by a Slight Modification of the von Graefe Method, Tr. Am. Ophth. Soc. **14**:482, 1916.

18 de Grôsz, E.: Quelques mots sur la technique de l'extraction intracapsulaire de la cataracte, Ann. d'ocul. **175**:320, 1938.

with the hook below and counterpressure above, and the cataract is made to tumble and to be delivered lower edge first.

While on the whole the advantages of the tumbling maneuver have been accepted by most operators, it is generally believed that the hold of the forceps on the anterior capsule should be maintained throughout the operation. I [19] have shown that the greater resulting leverage which was thereby exerted on the capsule of the lens during the tumbling maneuver resulted in a greater frequency of rupture of the capsule, particularly in nonpliable cataracts.

Recognizing the value of the tumbling maneuver, and realizing the difficulty of delivering hard lenses as tumblers solely by pressure from without, Smith,[20] in 1926, modified his method as follows: A squint hook was first applied over the sclera at 6 o'clock, and with pressure the tension of the vitreous was raised to the point required for dislocation. To prevent the lens from moving to the middle of the incision and the zonule giving way first at this point, a broad spatula was placed on flat over the incision, which closed the incision and kept the lens from shifting upward. The hook was then pressed straight back over the sclera below, to make the zonule give way at this place. The lower border of the lens tumbled and came forward, swinging about a transverse axis. The pressure was then partly relaxed, and the hook pushed the cornea in below and behind the lens. The spatula was removed from the area of the incision above, and the lens then slowly appeared. With the soft cataract this spatula maneuver was not necessary, as the lens molded and readily made its exit. Smith expressed the opinion that this method of extracting hard and soft lenses as tumblers would replace all methods of intracapsular extraction with vacuum spoon or forceps.

Sinclair [21] devised another way to prevent the upper edge of the lens from coming forward before the lower edge is dislocated, by using a capsule forceps with a fenestrated flange at the base of the branches. The heel gives support to the scleral lip of the wound during the first stage of dislocation of the lower margin of the lens. This support is released as soon as the subluxation of the lens has been accomplished, i. e., when the lower part of the lens is seen to rise into the pupil. External pressure is applied over the sclera 2 mm. below the limbus by a special instrument called a repositor (a wire grid). When the lens is subluxated, the direction of pressure is changed, and the direction of

19. Knapp, A.: On Methods of Dealing with Capsule in Cataract Extraction; Arch. Ophth. **50**:115, 1921.

20. Smith, H.: New Technique for Expression of Cataractous Lens in Its Capsule, Arch. Ophth. **55**:213, 1926.

21. Sinclair, A. H. H.: Intracapsular Extraction of Cataract, Tr. Ophth. Soc. U. Kingdom **52**:lvii, 1933.

traction becomes somewhat oblique with release of pressure with the flange. In my hands this maneuver led more frequently to rupture of the capsule.

Mendoza [22] found that in the intracapsular extraction there is danger of the cataract slipping into vitreous on the operator's attempting to grasp the capsule. To prevent this, he exerted pressure with the knee of the forceps against the upper margin of the incision as the hook was applied below. The lens was then caught between the forceps and the hook, and the capsule was easily seized.

Smith objected to any capsule forceps because it was not flexible and was apt to fail during the operation, by tearing the capsule or by losing its grip. He was not in favor of any attempt to pull out the lens by main force, as a strain put on the suspensory ligament all around could not succeed in subluxating the lens. In the intracapsular extraction the lens must swing on a transverse axis so as to concentrate the strain on one or two points. When the ligament has given way at one point, the lens can then be dislocated from the hyaloid fossa, and then only can it be removed from the eye. It is important to stress that in all dislocations the vitreous, in its hyaloid membrane, is made to press forward and thus rupture the attachment of the lens to the suspensory ligament.

Verhoeff,[23] in 1927, published the following ingenious method of intracapsular cataract extraction: After the section, external pressure on the lens was made below, thus causing the head of the lens to tilt forward, and the capsule was grasped at its upper equator. The lens was straddled on its anterior and posterior surfaces with a special forceps, shaped like a ring. To do this, the anterior zonular fibers must be ruptured. The lens was then rotated from side to side and the remainder of the capsular attachment ruptured. Moderate pressure was exerted at the lower limbus below with a special ring-shaped expressor [24] while maintaining the grip with the forceps, and the cataract in its capsule was then slowly extracted head first. The anterior displacement of the cataract and the grasping of the capsule were facilitated when an iridectomy or a meridional iridotomy was practiced.

In the Verhoeff operation the grasping of the upper margin of the cataract was easiest in the immature cataract. The capsule ruptured most frequently at time of delivery; then, after the usual extraction of the nucleus and cortex, the capsule was separately seized and extracted. During extraction the lens must be pressed against the posterior margin

22. Mendoza, R.: Die Kataraktextraktion in der Kapsel nach Elschnig, Zentralbl. f. d. ges. Ophth. **27**:169, 1933; La extracción de la catarata en su cápsula, segun Elschnig, Arch. de oftal. hispano-am. **32**:85, 1932.

23. Verhoeff, F. H.: New Operation for Removing Cataracts with Their Capsules, Tr. Am. Ophth. Soc. **25**:54, 1927.

24. Verhoeff, F. H.: Lens Expressor, Tr. Am. Ophth. Soc. **28**:305, 1930.

of the incision to hold the vitreous back and to avoid its loss. The dislocation is effected principally by traction and by moving the forceps from side to side, but counterpressure is important, as without it the capsule is apt to rupture.

Lindner [25] followed Verhoeff's procedure, and, after exposing the upper equator of the lens and grasping it with the Verhoeff forceps, extracted the lens with traction and counterpressure. This author used a modified Suarez-Mendoza suture and a peripheral iridectomy.

Kirby [26] attempted a preliminary dislocation below, according to Smith's method; the cornea was then retracted with a suture to permit direct inspection; the capsule was grasped above, and extraction followed with pressure below, according to the Verhoeff method. Kirby also developed a method of direct rupture of the zonule by stripping it from its attachment to the capsule and used it when he found the zonule resistant.

Elschnig combined the procedure of forceps traction on the capsule after dislocation below and tumbling of the lens. With his many publications, he added greatly to the introduction of the intracapsular forceps operation. Elschnig's additions to the intracapsular operation consisted in a retrobulbar injection and a superior rectus suture. His forceps is a modified Kalt type, and he practices a buttonhole iridectomy.

In Arruga's [27] operation the capsule is grasped with his special forceps as low as possible, beneath the iris with an opening of 4 mm. Traction is exerted upward and laterally. The nearer the periphery of the lens the traction is made, the more likely will be the zonule to tear. Arruga uses a curved hook, but makes very little counterpressure, and uses the hook only to follow up the lens as he draws it out of the section. Immediately after the section and after two peripheral iridotomies, the suture is put in at 12 o'clock. At the conclusion of the operation, two additional sutures are placed, and the iris is replaced. Arruga claimed that he ruptured the capsule in only from 3 to 4 per cent of cases. He was able to remove lenses with his method in persons 30 years of age (zonular cataract). Loss of vitreous occurred in from 3 to 4 per cent of the cases.

Operators vary on the importance of traction with the forceps as compared with external pressure with the hook or other instrument in subluxating the lens. Smith stated the opinion that more reliance should be put on pressure with the lens hook and less on traction with the forceps. It is self evident that too much traction or too strong a grip

25. Lindner, K.: Ueber Abänderungen der intrakapsulären Staroperation, Ber. ü. d. Versamml. d. deutsch. ophth. Gesellsch. **52**:392, 1938.

26. Kirby, D. B.: Development of System of Intracapsular Extraction of Cataract, Am. J. Ophth. **27**:124, 1944.

27. Arruga, H.: Les détails techniques de l'extraction intracapsulaire du cristallin, Bull. et mém. Soc. franç. d'opht. **46**:270, 1933.

with the forceps ruptures the capsule, while vitreous prolapses more readily from pressure than from traction. The relation of traction to external pressure in the maneuver of subluxation has been expressed by several authors as follows: Davis employs 95 per cent pressure and 5 per cent pull; Gradle, 80 per cent pressure and 20 per cent pull; Gailey uses more pressure than pull, while Lagrange and Spaeth use only traction. Arruga depends principally on traction and uses the hook only to follow up the lens as it is drawn out of the section. Verhoeff subluxates by torsion and traction. In my opinion, the forceps should hold the cataract with gentle traction while the external pressure with the hook succeeds in effecting the subluxation, as traction is more likely to rupture the capsule than pressure.

It is essential to realize the importance of patience in this operation, since it is a procedure that takes much longer than the usual extracapsular operation. The subluxation must be done very slowly so as to allow the molding of the cataract, especially when operating with a round pupil, and the percentage of successful intracapsular subluxations, without rupture, will be greatly increased.

ACCESSORY STEPS

There are a number of accessory steps which, in the intracapsular operation especially, have added greatly to the facility and safety of the operation.

Akinesia.—While akinesia is important in every form of cataract operation, it has demonstrated its worth particularly in the intracapsular procedure, as control of the eyelids is essential to the safety of the operation. Smith made an important contribution to the intracapsular technic by devising a method of retracting and controlling the lids with the aid of a specially trained assistant, which was described as follows: On completion of the section the speculum was removed; the upper lid was drawn forward from the eyeball with a large, blunt-tipped tenotomy hook, and with the fourth and fifth fingers of the same hand the eyebrow was pushed up, so that the orbicularis action was controlled. The lower lid was pulled down with the index finger of the other hand. This maneuver was then simplified with the use of the Fisher retractors.

A means of inducing temporary paralysis of the orbicularis muscle was devised several years ago by van Lint [28] and O'Brien [29]; this has led to the two methods which are now in general use. The first method consists in a submuscular injection of the eyelids with an anesthetic agent. It is not always possible to obtain a complete effect with this procedure, and the edema of the lids is apt to get in the way of the

28. van Lint: Astigmatisme post-opératoire dans l'extraction de la cataracte avec glissement de la conjonctive, Ann. d'ocul. **151**:418, 1914.

29. O'Brien, C. S.: Akinesia During Cataract Extraction, Arch. Ophth. **1**:447 (April) 1929.

operator. The blocking of the seventh nerve at the stylomastoid foramen (Wright,[30] Heuven and Campos) was an improvement but was not sufficiently simple for general adoption.

O'Brien's method, which consists in a deep injection anterior to the condyloid process, has given good results when the technic was mastered and the procedure given time to act. The effect of the O'Brien method is so complete that after the operation care must be taken to close the palpebral opening. This form of akinesia should be used not only in cataract operations but in every procedure in which it is necessary to throw the circumorbital musculature out of action. With the aid of these more perfect procedures of anesthesia, the speculum need not be removed after the completion of the section and, in the absence of complication, can be left in place until the end of the operation.

In addition to the local anesthetic, a subconjunctival injection is desirable to anesthetize the iris. This is best done under the superior rectus muscle, so as not to obstruct the area of section. A retrobulbar injection is used by many surgeons to anesthetize the ciliary ganglion. This increases the anesthesia of the eyeball and often weakens the action of the inferior rectus muscle, which is desirable, as the turning down of the eyeball during the intracapsular operation is not without danger. The retrobulbar injection may cause a softening of the eyeball, which in the opinion of many surgeons is favorable, as it reduces the tendency to prolapse of the vitreous. If this softening is extreme, however, the proper conduct of the operation may be interfered with; so it is best to give the injection just before the operation. To avoid hemorrhage into the orbit, this injection should be made close to the eyeball, and not deep into the orbit.

Superior Rectus Suture.—Placing of such a suture is another step which is often of great help, as it is the only way to direct the eyeball downward without making the edges of the wound gape. This device of Angelucci and Blaskovics was applied by Elschnig to the intracapsular operation. It is self evident that the suture must go through the tendon; a long-toothed forceps is needed to do this, after a preliminary injection of an anesthetic into the muscle has been made, as this step is otherwise painful. I have found that this suture, if attached to some fixed object, increases the intraocular pressure and may be in the way; so I prefer to leave the suture loose, ready to use when it is necessary to direct the eye down, as in threatened prolapse of the vitreous. The insertion of the suture late in the operation is obviously difficult.

Iridectomy.—The question of iridectomy has been answered in a number of ways. A complete iridectomy undoubtedly makes the grasping of the capsule with the forceps easier, and it also is the best pre-

30. Wright, R. E.: Akinesia During Extraction of Cataract. Arch. Ophth. **2**:691 (Dec.) 1929.

ventive of prolapse of the iris, which in the intraocular operation is an especially unpleasant complication; in the presence of any complication during the operation the old rule of performing an iridectomy holds true. Aside from the resulting optical imperfection, with increase of glare, and the cosmetic objection, the greatest drawback of iridectomy in the intracapsular operation is that it allows the vitreous to come forward after the extraction of the lens, and this favors the vitreous becoming attached to the cornea or entangled in the incision, with consequent serious complications. Most of my intracapsular operations were done with complete iridectomy, though I realize now the correctness of the last-named objections.

Buttonhole Iridectomy.—To obviate the loss of a round pupil in cataract surgery, Chandler, of Boston, in 1890, suggested a peripheral buttonhole iridectomy. This became known in European literature as the Pflüger-Hess procedure and is now used by many intracapsular operators. Some operators made from one to three peripheral openings in the iris. Peripheral iridectomy has greatly succeeded in preventing prolapse of the iris and preserves the optical advantages of the round pupil.

Iridotomy.—The buttonhole iridectomy was replaced by some operators with iridotomy. This consists in making a small equatorial incision at the root of the iris with the ordinary fine-pointed or the de Wecker scissors. This step was especially advocated by Dimmer and was later adopted by Elschnig in his intracapsular technic. Some surgeons think that the resulting opening is not large enough to prevent prolapse. Its one objection is that it is not always easy to perform, and the possibility of cutting into the vitreous is always present. This injury to the vitreous may explain some of the complications which develop in otherwise uncomplicated extractions, such as low grade inflammatory reactions, of which the updrawn pupil is the most striking. The buttonhole iridectomy or iridotomy can be done before or after the extraction of the lens; this step is more easily and more safely performed before the extraction of the cataract, and with the tumbling maneuver the lens is not caught in the coloboma of the iris.

In addition to the administration of sedatives, these steps have greatly succeeded in making the operator independent of the patient's cooperation and have removed many of the dangers of the cataract operation.

Corneal Sutures.—These were very slow in adoption. Elschnig,[31] speaking of wound sutures, commented on how slowly ophthalmic surgeons adopt advances in general surgery. Czermak,[32] in 1888, was

31. Elschnig, A.: Ueber die Naht bei der Altersstaroperation, Klin. Monatsbl. f. Augenh. **76**:30, 1926.

32. Czermak, W.: Ueber Extraction der Cataract ohne Iridectomie mit Naht der Wunde, Wien. klin. Wchnschr. **1**:592, 1888.

probably the first to pass a suture through the cornea and sclera on both sides of the center of the incision after making the section. He abandoned the method on account of infection and prolapse of the iris.

After a number of years, interest in suturing slowly developed, and the necessity of the sutures passing through the corneal and scleral tissues in order to obtain exact coaptation of the wound surfaces without overriding is now generally recognized. The sutures must not cause traction or deformity of the eyeball.

The methods of suture can now be divided into those in which the sutures are applied before and those in which they are applied after completion of the section. The first type apparently originated with Suarez de Mendoza,[33] who made an external incision in the cornea and then introduced a suture through both edges of the wound, subsequently completing the section in the line of the incision.

In 1894, Kalt [34] suggested a much simpler method by passing before the section a vertical suture through the superficial layers of the cornea 1 mm. below the limbus and 3 mm. above, horizontally through the episclera and conjunctiva; the section was then made between the sutures. In the method of Liégard,[35] at the beginning of the operation a parallel horizontal suture was passed at the upper corneal margin and through the conjunctiva and episclera above. Elschnig [36] used this method in cases of threatened loss of vitreous and of luxated cataract. Stallard [37] described a suture similar to Liégard's. Cornet [38] regarded an intracapsular extraction without sutures as inconceivable and used the Gomez-Marquez suture, which is like Kalt's.

The suture methods applied after completion of the section are more or less the same. A simple and satisfactory method consists in passing the sutures through the conjunctival flap and the superficial layers of the cornea and of the sclera. These sutures are then returned through the conjunctival flap on emergence and, besides producing a firm closure of the wound, insure a conjunctival protection to the section. From one to six sutures are inserted, according to the views of the operator.

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33. Suarez de Mendoza: La suture de la cornée dans l'opération de la cataracte, Arch d'opht. **9**:444, 1889.

34. Kalt, E.: On the Corneal Suture in Cataract Extraction, translated by H. Knapp, Arch. Ophth. **23**:421, 1894; Bull. Soc. d'opht. de Paris, 1894, p. 118.

35. Liégard, H.: Une modification au procédé de suture de la cornée dans l'opération de la cataracte, Ann. d'ocul. **149**:119, 1915.

36. Elschnig, A.: Staroperation mit Naht, Klin. Monatsbl. f. Augenh. **75**:775, 1925.

37. Stallard, H. B.: Corneo-Scleral Suture in Cataract Extraction, Brit. J. Ophth. **22**:269, 1938.

38. Cornet, E.: D'une suture provisoire de securité pour l'extraction capsulo-lenticulaire de la cataracte, Ann. d'ocul. **175**:322. 1938.

The study of suturing led to an improvement in needles, in the suture material and in the necessary instruments. Kalt and Barraquer introduced especially fine needles, which required a delicate needle holder. Atraumatic needles were then devised, making the procedure easier. A suitable fine forceps was desirable.

On the other hand, several voices were heard (that of Imre and others) which proclaimed that sutures were superfluous and troublesome and that their removal was not always simple.

Three methods of suturing are now in use in the United States and show that the preoperative method of suturing is at present the favorite.

Verhoeff [39] devised a tunneling suture, in which a scleral incision is made at the limbus after a conjunctival flap has been dissected down; two sutures are introduced, each making a track in the sclera. The incision is then made which cuts the sutures, and new sutures are then passed through the old tunnels. This technic undoubtedly succeeds in accurate coaptation but is complicated and prevents freedom in making the corneal section.

McLean,[40] after dissecting down a conjunctival flap of 5 mm., makes a tangential incision partially through the sclera at the limbus. Two sutures are passed through the conjunctival flap; reversed, they are passed through the sclera above and come out in the scleral stroma at the cut section. The sutures are continued through the corneal stroma and emerge just beyond the base of the conjunctival flap. The sutures are drawn to one side, and the usual section is made with a cataract knife in the line of the external incision. This insures that the section is always in the limbal plane and that the sutures go sufficiently deep into the sclerocorneal tissues. The sutures close the incision tightly, and the anterior chamber starts to reform very soon.

Bracken [41] uses a double-armed suture, which takes a horizontal bite of 4 mm. in the cornea just below the limbus. After section, both terminal threaded needles are passed vertically through the deep episcleral tissue above the incision, at 11 and 1 o'clock, and the strands are loosely tied. After the delivery of the lens, the suture is immediately tightened, especially in the presence of any complication. Additional sclerocorneal sutures are passed at 10 and 2 o'clock. These sutures insure a quick reformation of the anterior chamber.

The suture applied before the incision renders the incision more difficult; freedom in making the section is interfered with; the iris is

39. Verhoeff, F. H.: Corneoconjunctival Suture for Cataract Operation, Arch. Ophth. **56**:137, 1927.

40. McLean, J. M.: New Corneoscleral Suture, Arch. Ophth. **23**:554 (March) 1940.

41. Bracken, F.: Complications Incident to Simple Intracapsular Extraction: Some Procedures Designed Toward Prevention, Arch. Ophth. **34**:427 (Nov.-Dec.) 1945.

apt to fall before the knife, with the early escape of aqueous, and the necessary enlargement of the section with scissors is not desirable. Sutures can be readily applied after the section, but especially sharp needles and suitable instruments are essential. Whatever suture method is used, it is imperative that nothing be done to interfere with healing; namely, there must be no traction of the flap and no constriction of the tissues; in short, the suture must be accurately applied.

A final point on the subject of sutures is their occasional difficulty of removal, though frequently they fall out of themselves. Absorbable surgical gut sutures are now being used by some operators, but this substance seems to be more irritating than silk. Finally, it must be remembered that sutures are an additional test of asepsis.

An accurate and early closing of the incision is undoubtedly a great step in advance in the after-healing of the cataract operation. It prevents many of the complications that frequently impair the success of the cataract extraction, such as prolapse of the iris, which, though not entirely prevented, is greatly reduced, and hyphema is definitely less frequent. The advantages of the early reformation of the anterior chamber will be taken up later. The suture is also of value in presentation of vitreous and in this instance must be tied immediately.

To insure further early restoration of the anterior chamber, either a solution of sodium chloride or air can be injected into the chamber at the conclusion of the operation. This counteracts any tendency to anterior adhesion of the hyaloid membrane or of the iris. Some operators prefer the saline solution to air, since a much firmer closure of the wound is necessary to retain the solution.

INSTRUMENTS

A number of suction apparatus have been devised, beginning with the first, by Hulen, Barraquer and Stoewer; simpler instruments were suggested by the Greens, Dimitry, Argañaraz, Rochon-Duvigneaud, Castroviejo and others, which avoided the complicated machinery and resulting difficulties of the pneumatic pump. They all succeeded in taking a grasp of the capsule in certain cataracts (intumescent and morgagnian) which offered difficulties for the forceps.

Capsule Forceps.—The capsule forceps must grasp the capsule in all varieties of cataract and preserve a firm hold without tearing the capsule. The first forceps used for the intracapsular operation was the Manolescu model, which was constructed like the convex curve of a blunt-tipped iris forceps. In 1909 Kalt devised a forceps on the Terson model with a blunt, bifurcated tip for the extracapsular extraction, with the purpose of tearing out a large piece of the anterior capsule. I began to use this forceps, in 1910, in the intracapsular operation and continued to use it until the Arruga forceps appeared; the Arruga model

was better, as it did not tear the capsule so easily. The Kalt forceps soon became popular as the intracapsular operation was taken up more generally, and it was modified in many ways. Other capsule forceps carry the names of Elschnig, Green, Sinclair, Lagrange, Imre, Blaskovics, Davis and Arruga.

The latest Arruga forceps has the following characteristics: The approximation of the two tips is perfect, and the pressure on closing the branches is uniform at all places; the margins neither cut nor are too round. The pressure up to the point of arrest is not strong enough to tear the capsule. The grooves on the internal surface of the branches are an important addition, as they aid in grasping a tense capsule; the tip is also more pointed, and the blades form a notch posteriorly, so they do not take hold of the capsule near the center of the lens, a technical point which usually interferes with the tumbling of the lens. The operator's fingers should be applied at the center of the forceps so as not to use too much force. Arruga claimed that if the forceps is in good condition and the technic is correctly followed, 90 per cent of the lenses should be subluxated.

It is well to remember that the forceps must take a firm hold at one point in order to concentrate traction on only a few of the meridional fibers. As soon as the initial tear has taken place, the separation of the remaining fibers is easily accomplished. The forceps must be small, as it has to find a place in the anterior chamber in addition to the tumbling lens if the operation is completed by traction. It has seemed to me, in the application of the forceps, that the broader the hold of the capsule and the larger the piece of the capsule seized, the greater the prospect of the forceps slipping. But if a smaller bite is taken on tilting the handle of the forceps forward, the capsule is more easily torn. When a broader grasp is taken, the upper meridian is more pulled on or distorted as the lens tumbles, and rupture of the capsule is more likely. A small bite concentrates on only a few meridional fibers, but it has the great disadvantage that it tears the capsule if the capsule is a weak one.

Csillag [42] constructed a forceps that grasped the capsule in a horizontal fold, to avoid excess tension in the tumbling maneuver. Rötth and Klein [7] expressed the belief that for the success of the intracapsular operation it is necessary that the capsule be grasped with the forceps and that the capsule be stronger than the zonule. These authors expressed the hope that when the ideal forceps is constructed the number of capsules which cannot be grasped will be reduced to a minimum. At the same time, the relation between the strength of the capsule and

42. Csillag: Querfalte fassende Starpinzette zur intrakapsulären Starextraktion durch Stürzen, Klin. Monatsbl. f. Augenh. **93**:375, 1934.

the zonule remains an important factor. If the zonule is very resistant, danger to the ciliary body is avoided because the capsule ruptures. The thickness of the capsule is of great importance.

Speculum.—This is an important instrument in the intracapsular operation. It must be light; it must protect the lashes; it must be easily removable with one hand. I have always used the model devised by Koster, late professor of ophthalmology in Leyden. This is a light and ingenious speculum made of piano wire. After the section, in the practice of many, the speculum is removed, and the lids are held apart by special retractors or by blunt hooks. With advances in akinesia, it is practical to retain the speculum in place throughout the operation. The Pretori speculum has been ingeniously modified by Blaskovics, Oláh [43] and Arruga. It is well adapted for the intracapsular operation, as it holds the eyelids away from the eyeball by supports, but the instrument is somewhat bulky and difficult to extract in an emergency.

It is not necessary to describe the course in the cases of intracapsular extraction. The freedom from reaction is well known; the eyes remain singularly white, and it is often unnecessary to instil atropine. Anything that interferes with the course of healing is usually a complication that has occurred during the operation, and this subject will be discussed in the following section on complications.

COMPLICATIONS

The complications of the intracapsular operation are to a certain extent dependent on the improper selection of the cataract. There are several forms of cataract which lend themselves most readily to the intracapsular extraction. It is well to remember that with age the capsule thickens and the suspensory ligament atrophies. As a result, a dislocation of the cataract in the young is impracticable, and the determination of how much traction can be exerted without danger to the ciliary body is a matter for each operator's experience. Histologic changes have not been noted in the ciliary body on microscopic examination of eyes which have been operated on, though I have the distinct impression that cyclitis has resulted in some of my cases in which the subluxation was difficult.

The so-called intumescent cataract is an early cataract in which the cortex is swollen; the capsule is tense and offers the greatest difficulty to a satisfactory hold with the blunt forceps. The forceps slips off, and if a grasp succeeds in holding, the thin capsule frequently ruptures. The seizure can be facilitated by tilting the handle of the forceps forward so that more of the points of the blades is engaged and a smaller

43. Oláh, E.: Technique of Preparing for Cataract Operation, Am. J. Ophth. **15**:626, 1932.

area of the capsule is seized, though this increases the likelihood of capsular rupture.

It is with cataracts of this type that the suction procedure is helpful. The rupture of the capsule results in conditions found in the extracapsular operation and becomes complicated if prolapse of the vitreous is present. The sclerosed, or amber-colored, cataract usually offers few difficulties, while the very frequent nuclear and posterior cortical cataracts are the most favorable. The hypermature (morgagnian) cataract is often difficult to grasp, and the shrunken disciform variety offers little resistance to the vis a tergo of the vitreous and is difficult to extract in the capsule.

In performing the intracapsular procedure, attempts at subluxation should be kept within reasonable limits. If, on varying the direction of traction and counterpressure, no result is obtained after a certain time, it is well to desist and to change to the toothed forceps. With cataract in the immature stage it is always best to wait until the anterior chamber is sufficiently deep to permit an adequate section, as there is nothing more important in cataract surgery, especially in the intracapsular extraction.

Loss of Vitreous.—This is the most important complication. Much has been written minimizing loss of vitreous in the intracapsular operation, but it cannot be sufficiently stressed that any disturbance of vitreous is serious and should be avoided. It is not the amount that is so important; it is the presence of the hyaloid membrane in the incision, which interferes with the normal healing of the incision and leads to inflammatory changes in the eyeball. The more experience one gathers in cataract surgery, the greater respect one acquires for the vitreous. The changes which the vitreous undergoes with age and as a part of the cataractous process may be a factor in prolapse of the vitreous.

It is an old clinical observation that loss of fluid vitreous is the less serious complication, though its amount cannot be controlled and the immediate closure of the wound with a tight suture is essential. In cases in which the loss has been great and the eyeball has collapsed the injection of saline solution has been practiced; by filling out the eyeball, this facilitates the coaptation of the wound edges. The loss of vitreous does not lead to detachment of the retina, but the ensuing inflammatory changes in the vitreous may form adhesions to the retina which, in pulling on the retina, detach it. The occurrence of loss of vitreous in the intracapsular cataract extraction has unquestionably been reduced by advances which have been made in the accessory steps of the operation. The immediate tying of the sclerocorneal sutures, in the opinion of many, is also of great benefit if the vitreous presents or is lost during the operation. At the same time, the presence of sutures

may interfere with a clean excision of the prolapsed portion of the vitreous.

The importance of loss of vitreous during the cataract operation depends greatly on the stage of the operation in which the loss takes place. In the intracapsular forceps operation loss of vitreous generally occurs after the cataract has been extracted; and prolapse in this terminal stage does not require the introduction of an instrument into the eyeball, and the resulting inflammatory changes are minimized. Prolapse occurring during the operation or before the delivery of the cataract requires particular measures, which will be described in the next paragraph. In any case, the incision must be freed of vitreous, so that the edges of the wound can close accurately, as a firm cicatrix is necessary to prevent late infection.

In my analysis of 500 successive cases [44] I find 42 cases of loss of vitreous. These cases occurred as follows: In the first hundred cases, 16; in the second hundred, 9; in the third hundred, 7; in the fourth hundred, 5, and in the fifth hundred, 5.

The incidence of loss of vitreous given in reports of Elschnig, Verhoeff, Arruga, Davis and others is about 5 per cent. The improvement in my series can be explained by better anesthesia and better technic.

In considering prolapse of vitreous, it is important to note in what stage of the operation the loss of vitreous occurred. Thus, in my series the loss occurred (1) directly after section in 5 cases, (2) during subluxation of the cataract in 12 cases, (3) after delivery of the cataract in 12 cases and (4) at the end of the operation in 12 cases.

Prolapse occurring directly after incision (stage 1) was usually due to a dislocated lens, and vitreous appeared in the anterior chamber during the incision. This complication occurs as well in any type of extraction of cataract and so can be dismissed from this consideration. Vitreous was lost about equally in each of the other stages. Prolapse during subluxation (stage 2) occurred when the capsule forceps dislocated the lens and ruptured the hyaloid membrane at the same time.

The rupture of the hyaloid membrane may take place in any part of the circumference; this was noted by the appearance of a black gap between the pupillary margin and the cataract and by the deepening of the anterior chamber. When this occurs, the speculum should be replaced with retractors; the capsule of the cataract should be grasped again with the blunt forceps, if it has been released, and the dislocation completed below and the lens extracted, a procedure which often succeeds without additional loss of vitreous, or, if the capsule cannot be grasped, loop extraction is performed. The rupture of the hyaloid mem-

44. Knapp, A.: Complications of the Forceps Intracapsular Cataract Operation Based on an Analysis of Five Hundred Successive Cases, Arch. Ophth. **16**: 770 (Nov.) 1936.

brane may be due to the application of too much traction with the forceps, to an adhesion of the capsule to the hyaloid membrane or to an unexpected movement of the patient.

In prolapse after delivery of the lens (stage 3 of the operation) the vitreous directly followed the lens as if it was adherent to it or because too much pressure was applied. In the final stage (stage 4) the loss of vitreous occurred in the process of replacing the iris or of adjusting the conjunctival flap or on removing the speculum. The relatively large number of cases of loss of vitreous in the last stage of the operation was probably due to the fact that after extraction the vitreous body was deformed, extended forward and was thereby readily injured by the spatula.

Final vision in the cases with loss of vitreous in this series was as follows: 20/20 in 6 cases, 20/30 in 17 cases, 20/40 in 5 cases, 20/50 in 2 cases, 20/60 in 2 cases, 20/70 in 6 cases, 5/200 in 2 cases, perception of hand movements in 1 case and perception of light in 1 case. The poor visual results were due in part to maculae corneae in 2 cases (vision of 20/70), to central choroidal changes in 2 cases (vision of 5/200), to partial subchoroidal hemorrhage in 1 case (vision of 5/200), to atrophy of the optic nerve in 1 case (perception of hand movements) and to retinal detachment in 1 case (perception of light).

Fortunately, in this type of intracapsular operation the amount of vitreous lost was small; the loss generally occurred after the delivery of the lens, so that no instrument was introduced into the eye and no trauma was done to the body of the vitreous, with resulting opacities and organizing bands. The fear that detachment of the retina may follow loss of vitreous is not justified; the small amount of vitreous lost cannot be a factor unless opacities of the vitreous or other inflammatory reactions follow and cause changes in the structure of the vitreous which lead to detachment. This phase will be taken up in the consideration of retinal detachment.

The loss of vitreous in the intracapsular operation is often followed by a characteristic deformity, i. e., an updrawn pupil. In fact, even when no vitreous is lost, the pupil may be distorted if in the cases of iridectomy care has not been taken to replace the iris pillars carefully. The reason for the updrawn pupil is not always clear, but it can be assumed that an injury to the vitreous has occurred, which has led to a cicatricial contraction of the vitreous and the adherent iris. This may reach such an extent that the pupillary opening is obliterated and an iridotomy is necessary. Distortion of the pupil, according to Vannas, is caused by entanglement of vitreous in the incision or entanglement of threads of a persistent pupillary membrane. Kubic blamed it on traction of the zonular fibers in instances of disturbance of the vitreous. The incarcerated vitreous undergoes fibrous degeneration and shrinks (von Sallmann).

Another complication is rupture of the capsule during the extraction of the cataract. Its severity depends on whether the hyaloid membrane is also ruptured and in what stage of the extraction the rupture occurs. If rupture takes place before delivery of the cataract, the capsule has to be kept hold of, or another grasp must be taken. If the rupture takes place in the terminal stage, the capsule usually can be easily extracted after delivery of the cataract. In my series this rupture occurred in 20 cases; the capsule was subsequently extracted in 18 cases, with satisfactory visual results. When the capsule cannot be grasped and extracted, its retention need not be troublesome if the pupil is free and the capsule is not adherent to the section.

Iridocyclitis.—After the intracapsular operation mild inflammatory reactions are often due to slight trauma to the ciliary body or to the vitreous body. The bulging vitreous in the pupillary area will be found studded with pigment granules. Opacification of a protruding vitreous tissue, such as occurs after discission of the after-cataract in the extracapsular operation, is unusual.

The complication of iridocyclitis was observed in 33 of this series of 500 cases. Iridocyclitis occurred in the cases of intracapsular extraction just as in the cases of extracapsular extraction, but much less frequently in the former, as the infection aggravated by the cortical remnants and the capsular tags, which are responsible for many complications in the latter operation, is absent.

In my series I noted that there were cases of mild iridocyclitis; moderately severe iridocyclitis with synechia, updrawn pupil and thickened hyaloid membrane, and, finally, a severe form. It is well known that after an intracapsular operation the pupil is easily dilatable; cortical remnants and inflammatory thickening of the capsule are absent, and posterior synechia and opacity of the hyaloid membrane rarely develop. All the patients with the mild form recovered with good vision. The patients with moderately severe involvement had posterior adhesions and a thickened hyaloid membrane; resultant vision was fair; discission or iridotomy was rarely necessary.

The severe form occurred in patients with poor general health and was observed in 5 persons. It is characterized by the nonreformation of the anterior chamber and by the development of a persisting opacity in the deeper layers of the cornea and is accompanied with congestion and tearing. This is followed by deep vascularization of the cornea, all the symptoms of severe iridocyclitis, and, later, glaucoma.

This serious condition, I feared, was due to exertion of too great traction on the ciliary body when the subluxation was more difficult than usual. While this may be partly true, a better explanation may be found in a condition with which ophthalmologists have become more familiar in recent years, namely, a downgrowth of epithelium into the anterior chamber.

This most interesting and serious complication of intraocular surgery requires further study, and, as its treatment is unsatisfactory, additional care must be taken at the close of the operation to attain early firm union of the sclerocorneal section.

Glaucoma.—The infrequency of this complication following intracapsular operation is readily explained by the absence of anterior adhesions of the capsule to the incision, which is the usual cause of secondary glaucoma in aphakic eyes, though exceptionally glaucoma may follow an anterior adhesion of the hyaloid membrane to the posterior surface of the cornea or to the incision. It is interesting to note that in cases in which a cataract developed in a glaucomatous eye and an intracapsular operation was attempted the suspensory ligament was found to be brittle, so that the subluxation of the lens readily occurred, and after removal of the cataract in its capsule the ocular tension frequently remained reduced.

Trauma to the corneal endothelium with the capsule forceps may cause the hyaloid membrane or the iris to become adherent before the anterior chamber is established, particularly in the tumbling maneuver, and glaucoma may result. This form of glaucoma is always a difficult complication to deal with; that the section was too small is probably a factor in its development. Another type of glaucoma occurs when the vitreous becomes adherent to the line of incision, and it is usually associated with adhesion of the iris and may also be due to an especially slow reformation of the anterior chamber. Arruga stated the belief that glaucoma is due to the vitreous obliterating the angle of the iris and agreed with me that a peripheral adhesion of the iris may result from nonreformation of the anterior chamber and thus cause glaucoma.

This is another reason for accurate suturing of the corneal incision and the prompt restoration of the anterior chamber. It is probable that the injection of air, or saline solution, into the anterior chamber at the close of the operation will help to prevent an anterior adhesion of the vitreous body, and in a secondary operation will help to prevent its reattachment (Hughes and Cole [45]).

Sugar [46] observed, on gonioscopic examination in 8 cases of glaucoma following the intracapsular extraction, that the angle of the anterior chamber was obliterated, just as in the cases of extracapsular extraction, and there was a similar delay in the reformation of the anterior chamber.

Glaucoma was observed in my series in 12 cases. In 3 cases it appeared at some time after the operation. In 9 cases it had been

45. Hughes, W. L., and Cole, J. G.: Technical Uses of Air in Ophthalmology, Arch. Ophth. **35**:525 (May) 1946.

46. Sugar, H. S.: Gonioscopy and Glaucoma, Arch. Ophth. **25**:674 (April) 1941.

present before the cataract and was relieved by the cataract operation in 6 cases, and in 3 cases the glaucomatous condition persisted after the cataract operation and had to be treated by instillation of drops or operation.

The intracapsular extraction has taught the value of the prompt restoration of the anterior chamber. This prompt restoration can be accomplished only by a clean section, which is free from entanglements, and by a firm union of the scleral and corneal surfaces of the wound with the aid of proper sutures.

Detachment of the Retina.—The relative frequency of detachment of the retina after extracapsular and intracapsular operations has been a source of controversy. I am convinced that this complication is less frequent after the intracapsular operation, a belief which is borne out by a consideration of the causes of detachment. Organization of vitreous bands does not follow the intracapsular operation, as it sometimes does after discission; this is probably explained by the relative absence of inflammatory reactions in cases of intracapsular operation. Formation of holes in the retina from vascular disturbance occurs in patients who have been operated on for cataract, just as it occurs in any old person.

Retinal detachment is a complication which is often attributed to loss of vitreous during the intracapsular operation. In my series of 500 successive cases retinal detachment occurred in 6.[47] In 1 of these cases there was slight loss of vitreous at the time of operation. The amount was small, and, in my opinion, unless this increased the opacities in the vitreous it could not have been a factor. Vision at first was 20/30, and the detachment occurred two months after operation. Of the other cases, the period from the operation to the onset of the detachment was one year in 1 case; one and one-half years in 3 cases and two years in 1 case. The condition present in all the cases was opacities of the vitreous, and I believe that the opacities, indicative of low grade cyclitis, were responsible for the detachment.

Arruga expressed the belief that detachment occurs more frequently after the intracapsular operation than after the extracapsular operation, though I believe that he qualified this statement with respect to "myopic eyes." I am not prepared to share this view, particularly since detachment of the retina after the extracapsular operation is explained by injury to the vitreous, such as happens after too deep a discission, which forms organized bands and adhesions between the vitreous and the retina and leads to retinal detachment. This condition does not exist in the intracapsular operation; no inflammatory changes occur in the vitreous after this operation unless vitreous is lost or cyclitis develops.

In considering the relation of loss of vitreous to retinal detachment, the amount of vitreous lost is an important factor, as well as the length

47. Knapp,[44] p. 774.

of time after operation that the detachment occurred. It is conceivable that a large amount of vitreous lost at operation might be a factor in causing detachment which occurred a short time after, but in 5 of the 6 cases of detachment there was no loss of vitreous at operation and the detachment followed from one to two years after operation.

Arruga (in a personal communication) suggests that the vitreous body when it no longer is held back by the zonulocapsular septum extends forward and becomes more movable and that thereby traction on the periphery of the retina easily follows with formation of holes and detachment.

Changes in the Hyaloid Membrane.—A peculiarity of the healing after the intracapsular operation is the persistence of blood on the hyaloid membrane in its natural color for months, frequently causing serious interference with vision.

A picture that resembles a secondary cataract consists in thickening of the hyaloid membrane, with resulting interference with sight. This is an unusual sequel and may require a cautious discission after a sufficient length of time has elapsed.

COMMENT

The amount of literature that has arisen on the subject of the intracapsular extraction is bewildering, but some general direction can be recognized. The trend seems to be in favor of an operation in which a firm hold is taken of the capsule with the forceps without tearing it, concentrating the traction to one area and with a hook or similar instrument exerting pressure externally at the lower corneal margin, in order to raise the vitreous pressure and to rupture the suspensory ligament at that point. Smith thinks that the vis a tergo pressure of the vitreous, and not direct trauma to the zonule with the hook, explains the rupture of the zonule.

After subluxation of the cataract, the extraction is completed with the aid of external pressure, by tumbling or by head-first delivery. Many operators maintain the hold on the capsule throughout the operation, but in my experience release of the forceps after subluxation of the cataract reduces the number of ruptured capsules. The tumbling maneuver is favored except in the Verhoeff method. In general, more reliance should be put on pressure with the lens hook and less on traction with the forceps, but the operator must vary between traction and pressure according to the conditions present, and the best method depends on a delicate adjustment of these two procedures.

Preservation of a round pupil is desirable, as the iris tissue acts as a support for the vitreous body. Firm closure of the section by deep sclerocorneal sutures insures prompt restoration of the anterior chamber. Though the forceps method of intracapsular extraction is steadily

gaining in popularity, attempts should be made to correct the difficulty in grasping some cataracts with forceps by improvement in technic and in instruments. At present the Barraquer method is the most appropriate for the intumescent cataract.

ADVANTAGES AND DISADVANTAGES OF THE INTRACAPSULAR EXTRACTION

The chief advantage of the intracapsular cataract extraction is that the operation is practicable in the immature stage of the cataract. Furthermore, the visual results are surely much better than after capsulotomy. There are not many systematic reports on successive cases to furnish a comparison with the results previously obtained with the extracapsular methods. In my series of 500 successive cases, the visual results were 20/30 or better in 90 per cent, whereas the figures for this visual acuity in the cases of extracapsular extraction ranged from 52 to 62 per cent.

The after-treatment is simpler and shorter, and no after-cataract operation is necessary. The freedom from inflammatory reaction is striking and leaves no doubt about the role of retained cortex and capsule in promoting an infection. The iridocyclitis after the extracapsular operation, the difficulties that arise in correcting the subsequent visual disturbances and the secondary glaucoma are as trying as any complications that the ophthalmic surgeon encounters.

The disadvantages of the intracapsular operation are that the operation is more difficult and that there is greater frequency of loss of vitreous. Granted the greater difficulties, there is no reason that the technic of the operation should not belong to every competent ophthalmic surgeon.

De Saint Martin [48] found that conditions most suitable for intracapsular extraction are the immature nuclear or cortical cataract, phacosclerosis and the mature cataract. Less suitable are the intumescent cataract in which the capsule is tense and slippery, the hypermature cataract, the cataract with large nucleus and fragile capsule, the shrunken cataract and the cataract associated with tetany.

Smith [49] stated that the intracapsular extraction is a difficult operation and capsulotomy is relatively easy and simple but that in skilled hands escape of vitreous is about the same in the two procedures. I cannot agree with this statement, as loss of vitreous in capsulotomy should be practically nil, while the best statistics on intracapsular cataract extraction give a loss in about 5 per cent.

Smith insisted on making a large enough section, even one of 190 degrees. Many operators fear a large section, not realizing that a small section means more pressure to dislocate the lens. Smith stated that if

48. de Saint-Martin, R.: L'extraction capsulo-lenticulaire de la cataracte, Bull. et mém. Soc. franç. d'opht. de Paris **46**:387, 1933.

49. Smith H.: Treatment of Cataract. Arch. Ophth. **50**:515. 1921.

the forceps technic is employed the hold with the forceps must be very delicate lest it rupture the capsule and that most of the work should be done with the hook. He suggested that if one feels for the corneoscleral ring with the hook and pulls toward the patient's feet, the lens will always roll forward. Hard cataracts are likely to burst on application of the forceps.

Elschnig,[50] on reviewing his results with the various intracapsular methods, came to the following conclusions: He abandoned the Smith operation because an iridectomy was always necessary and the loss of vitreous was too great. The Barraquer method was too difficult and caused too much loss of vitreous. He was pleased with the forceps operation and recommended it for general adoption. This maneuver succeeded in 80 per cent of cases; in 10 per cent the capsule ruptured, and in 10 per cent the forceps did not take hold. Of 468 cases from his clinic,[51] loss of vitreous occurred in 25. The capsule ruptured in 23 cases. In 40 cases the pupil was drawn upward; glaucoma was observed in 5 cases, and detachment occurred in 2 cases. Elschnig did not regard exophthalmos or myopia as contraindications, though in his opinion the intumescent and adolescent cataracts were not suited.

Blaskovics [52] expressed preference for the tumbling method. With this technic, the maturity of the cataract no longer needed to be considered. Bilateral operation was of great advantage for some patients and should not be discarded.

Wright [53] said that the fact that ophthalmic surgeons fall back on capsulotomy when things are not quite right shows that they regard it as a safer procedure. In his experience capsulotomy was freer from complications, especially in the postoperative period. He used the forceps in the intracapsular extraction and favored the tumbling maneuver; for morgagnian and intumescent cataracts he considered phacoeresis (Barraquer) preferable.

Kadlichy [54] found that one cannot predict the success of an intracapsular extraction from the appearance of the cataract. In a series of 200 cases, the operation succeeded with only 33 per cent of the hypermature cataracts and with 32 per cent of the intumescent cataracts.

50. Elschnig, A.: Altersstarextraktion in der Kapsel, Ztschr. f. Augenh. **75**:1, 1931.

51. Kubik: Ueber die intrakapsuläre Starextraktion nach Stanculeanu-Török, Klin. Monatsbl. f. Augenh. **82**:592, 1929.

52. Blaskovics: Fortschritte auf dem Gebiete der Staroperation und Aenderung der Indikationen, Orvosképzés **26**:22, 1936; Zentralbl. f. d. ges. Ophth. **37**:58, 1936.

53. Wright, R.: Lectures on Cataract, Am. J. Ophth. **20**:5, 1937.

54. Kadlichy, R.: Kann man aus dem Aussehen der Katarakte die Möglichkeit der intrakapsulären Extraktion erkennen Ceskoslov. oftal. **2**:225, 1935; Zentralbl. f. d. ges. Ophth. **36**:614, 1936.

In general, the intracapsular method succeeded in 73 per cent, and the extracapsular method was practiced in 23 per cent. The capsule could not be grasped in 15 per cent of cases, and it ruptured in 12 per cent. Vitreous prolapsed in 3 per cent.

In addition to the cataracts that Smith [49] laid down as unsuitable for intracapsular extraction, such as congenital cataract and juvenile cataract in persons up to 30 years of age, Holland [55] mentioned the large, prominent "ox-eye" cataracts in full-blooded, plethoric, fat persons, cataracts in apparently normal persons that resist legitimate pressure, cataracts in persons between 35 and 50 years of age in which the zonule has proved too resistant, cataract associated with glaucoma, glaucomatous cataract and traumatic cataracts. Such cataracts did not amount to 5 per cent of all types.

According to Kugelberg,[56] the advantages of the intracapsular extraction were a black pupil, free from cortex or capsule, a short convalescence, no inflammatory reaction and no secondary operation, while the only disadvantage was danger of loss of vitreous. He stated that the forceps extraction was the best method for the intracapsular method. In his experience, the technic of intracapsular extraction was more difficult, but the visual results were better and the percentage of loss of vitreous was small. In cases of incipient and immature cataract, the cataract was firm and easily grasped and the lens had a good form, facilitating the tumbling and final extraction of the lens. In youth the zonule was firm; in hypermature and in tremulous and morgagnian cataracts the zonule tore easily and the lens might slip into the vitreous. In intumescent cataract the capsule tore easily. The hard and pigmented cataracts were not suited, while cataracts associated with myopia, diabetes and heterochromic cyclitis and the nuclear cataracts of glaucoma were all favorable.

In Barraquer's [14a] opinion, intracapsular extraction by external pressure (Indian method) caused rupture of the hyaloid membrane, prolapse of the vitreous, impaction or loss of vitreous with late complications and iridocyclitis from lesions of the ciliary body and keratitis. The forceps operation succeeded (1) when the cataract was soft and deformable, so that a fold in the capsule could be made; (2) when the capsule was tough enough to resist traction at the place of the fold, and (3) when the zonular fibers had lost their elasticity and permitted tearing at their insertion on the crystalline lens on gentle traction. If these three conditions were not fulfilled, (1) the capsule could not

55. Holland, H. T.: Some Contraindications to the Intra-Capsular Operation for Cataract Based on 8,000 Cases of Intra-Capsular Operation Indian M. Gaz. **57**:296, 1922.

56. Kugelberg, F.: Staroperation in der Kapsel, Zentralbl. f. d. ges. Ophth. **26**:564, 1932; Extraction of Cataract in Capsule, Hygiea **93**:689, 1931.

be grasped and there was danger of luxation, (2) a capsulotomy had to be performed and (3) the ciliary region was traumatized and the vitreous was deformed.

According to Barraquer, the poor results obtained by some operators with the suction method were due to incorrect technic and to an imperfect apparatus. Phacoeresis avoided the complications of the forceps operation, such as rupture of the capsule, prolapse of vitreous and secondary reactions. To get the best results with the suction method, three conditions must be met: The suction cup must be of suitable size; there must be correct dislocation of the lens into the anterior chamber by disarticulation from the hyaloid fossa, without injury to vitreous and to the pupil, and, finally, the cataract must be extracted from the anterior chamber with the aid of the suction cup or by pressure on the cornea.

Complications listed against the Barraquer operation were opacities in the vitreous, detachment of the retina and late hemorrhages. These were due to rupture of the hyaloid membrane or to impaction, i. e., faulty technic. Late iridocyclitis was due to traction on the ciliary region (incorrect management of the vacuum). Hyphema and hernia of the vitreous in the pupil have disappeared since Barraquer began, in 1936, to use the present sclerocorneal suture; these accidents resulted from minute openings in the deeper layers of the incision, with escape of aqueous under the conjunctival flap.

Arruga said that the eresiphake is a very delicate instrument, like any pneumatic apparatus, and that traction on the zonule cannot be limited. The forceps was not suitable in cases of swollen cataract. The capsule should be grasped in the peripheral part, so as to limit traction to a very small sector of the zonule. In extraction with the forceps, Arruga depended mostly on traction, and in his experience damage to the ciliary body from traction was unusual. When the forceps did not take hold, he used the suction pump.

I have avoided head-first extraction and have found that two main problems might present themselves in the intracapsular operation: inability to grasp the capsule and rupture of the capsule. These problems should be solved with better forceps and with improved technic. The cataract was operable [57] as soon as the anterior chamber was deep enough to permit a satisfactory section and as soon as the patient was prevented from doing his work. The elasticity of the zonule and the thickness of the capsule could not be predicted, except by the age of the patient. Contraindications were the intumescent and morgagnian varieties. Tumbling was the safest procedure; if the lens was not readily subluxated, an extracapsular operation was resorted to.

57. Knapp, A.: Certain Aspects of the Intracapsular Extraction of Cataract by Forceps, Arch. Ophth. **16**:419 (Sept.) 1936.

Amsler [58] correctly stated that the intracapsular extraction had great social advantages, as it extended the indications for operation, healing was more rapid and there was no after-cataract, but that the operation was more difficult. The dangers were greatly lessened by improved technic, such as akinesia. Luxation failed in 20 per cent of his series. In cases of senility, dementia and complete mature cataract the author preferred the extracapsular operation.

Degrazia [59] found two main objections to the forceps operation: (1) frequent rupture of the capsule and (2) slipping of the forceps when the capsule was tense and smooth. Though in Barraquer's operation there were fewer ruptures and it was applicable to more types of cataract, greater delicacy was necessary and loss of vitreous was greater. In the forceps operation the technic was easier, there was less loss of vitreous but a great number of capsules ruptured and there was a large number of unsuitable cases. With both methods the postoperative convalescence was simple with the same excellent visual results and a minimum of inflammatory reaction.

Degrazia expressed the opinion that in the forceps operation tearing of the zonular fibers occurred at the insertion in the ciliary body and frequently caused iridocyclitis. On the other hand, in the suction method the zonular fibers were torn at their capsular attachment.

Poyales [60] rejected the Smith method and found the drawback to Barraquer's procedure to be the difficulty of exactly gaging the vacuum, which made the action of the pump uncertain. The forceps method was good when the resistance of the capsule was stronger than that of the zonule.

Meller [61] described the various complications of the intracapsular operation and stated his opinion that it was indicated only in a carefully selected group of cases. Without underestimating the undoubted advantage of the successful intracapsular operation, he said that he hesitated to replace a perfectly safe procedure with a definitely more risky operation.

Kirkpatrick recognized the advantages of intracapsular extraction but concluded that the operative risks and complications did not justify its adoption, except in a few selected cases, principally on account of loss of vitreous.

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58. Amsler, M.: De quelques opérations oculaires, Schweiz. med. Wchnschr. **66**:1268, 1936.

59. Degrazia, N. C.: Ueber die Staroperation, Arq. clin. oftal. **6**:78, 1939: Zentralbl. f. d. ges. Ophth. **44**:628, 1940.

60. Poyales, F.: Die Totalextraktion der Katarakt, Arch. de oftal. hispano-am. **28**:327, 1928; Zentralbl. f. d. ges. Ophth. **20**:488, 1929.

61. Meller, J.: Ueber den Anteil der Wiener augenärztlichen Schule an der Entwicklung des Verfahrens, den grauen Star in der Kapsel auszuziehen, Wien. klin. Wchnschr. **50**:755, 1937.

Davis[62] preferred the combined extraction method and extracted the lens by tumbling in 92 per cent of his cases; in the rest he extracted the ruptured capsule separately. Rupture of the capsule was most common in cases of a completely sclerosed lens. He used a special forceps,[63] with which a large area of capsule was grasped. Loss of vitreous was 6 per cent. Hyphema occurred too frequently with any method of operation. In his opinion,[64] though the present trend was toward the intracapsular extraction with preservation of the round pupil, this operation was neither the easiest nor the safest method of extraction. Dunnington commented, in the discussion, that in operations with preservation of the round pupil the grip of the sphincter of the iris and the thin diaphragm of iris tissue were the retarding factors in prolapse of the vitreous, though the complications, when they did happen, were severer. The feature in favor of a complete iridectomy over the round pupil operation was the less frequent rupture of the capsule.

Preservation of the Round Pupil.—The advantages of preservation of the round pupil are well known, though iridectomy may be advisable in cases of chronic iritis and of glaucoma, in cases in which the pupil does not dilate and prevents the passage of the lens and, finally, in cases in which cooperation in the after-treatment on the part of the patient cannot be depended on. The preservation of a round pupil prevents the presentation of vitreous after the extraction, though the vitreous becomes deformed from the reduction of the intraocular pressure. This prevention is brought about by the intact iris tissue and the grip of the pupillary sphincter, undoubtedly increased by the customary use of physostigmine at the conclusion of the operation. The beneficial effect of the preservation of a round pupil in reducing the incidence of loss of vitreous has been observed by a number of operators.

Hughes and Owens,[65] in a series of intracapsular extractions with corneoscleral suture, showed that the loss of vitreous was reduced from 14.5 and 12.7 per cent, in cases with iridectomy, to 2.7 per cent, in the cases in which the intracapsular extraction was done with round pupil. This striking reduction in loss of vitreous must also be attributed to improved technic. In Bracken's experience, the loss of vitreous was much reduced when operating with the round pupil, in at least three fourths of the cases.

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62. Davis, F. A.: Personal Experiences with Intra-Capsular Cataract Extractions, Arch. Ophth. **19**:867 (June) 1938.

63. Davis, F. A.: Capsule Forceps for Intra-Capsular Cataract Extractions, Tr. Am. Ophth. Soc. **34**:239, 1936.

64. Davis, F. A., in discussion on Hughes and Owens,[65] p. 261.

65. Hughes, W. F., Jr., and Owens, W. C.: Extraction of Senile Cataract, Tr. Am. Acad. Ophth. **49**:251, 1945.

Sutures.—According to most operators, suturing has almost done away with prolapse of the iris, but opinions are not so uniform on the prevention of hyphema.

Leech and Sugar,[66] in comparing the results in cases in which deep sclerocorneal sutures were used with those in cases in which no sutures or only conjunctival sutures were used, concluded that in the former the number of cases of prolapse of the iris and of hyphema were reduced and the anterior chamber was reformed earlier. When prolapse of vitreous occurred during the operation, further loss was prevented by closing the wound securely after delivery of the lens. The patients were allowed up earlier and were given greater freedom, and restlessness was not so dangerous. The authors found most suitable the type of suture which was placed prior to making the corneal incision, and their suture is similar to the one described by Stallard. Barraquer also noted that his results were much improved after using corneoscleral sutures.

Prompt Reformation of the Anterior Chamber.—It has been shown how important is the prompt restoration of the anterior chamber, in prevention of several serious complications, and how this can be much facilitated by proper suturing, which thus becomes an important step in the operation. Some operators even speak of a water-tight anterior chamber, and one beginning to reform before the end of the operation; others regularly find the chamber reformed on the following day. The injection of air, or saline solution, is an important adjunct.

The complications ascribed to the slow reformation or nonreformation of the anterior chamber are due to interference with the intraocular circulation, whereby anterior peripheral adhesions of the iris develop or the hyaloid membrane of the vitreous body becomes adherent to the corneal endothelium, and glaucoma results. Another, very serious, complication is the downgrowth of epithelium into the anterior chamber.

Late Results.—It has been claimed that the intracapsular operation unduly traumatizes the eye, displaces the pupil and causes degenerative changes in the vitreous which damage the eye. To investigate these important claims, it seemed best to reexamine patients several years after operation. I was able to follow the course of 85 patients from ten to fiften years after operation[67] and found that 16 patients who had died had retained good vision, as shown at the last examination or as reported by relatives. Fifty-seven patients were reexamined, and it was found that vision was as good as after the operation or that it had improved; 5 of these patients had had slight loss of vitreous.

66. Leech, V. M., and Sugar, H. S.: Reduction of Post-Operative Complications in Cataract Operations with Corneo-Scleral Sutures, Arch. Ophth. **21**:966 (June) 1939.

67. Knapp, A.: Late Results of Intracapsular Cataract Extraction, Arch. Ophth. **55**:257, 1926.

In these 57 patients, the cornea was perfectly clear; there was no updrawing of the pupil and the coloboma of the iris was regular except in a few with slight distortion of the pupil from posterior synechia or from anterior adhesion of one pillar, due to prolapse of the iris or loss of vitreous.

The conditions for the examination of the vitreous in the cases of intracapsular operation were perfect, and the vitreous was found to be unusually clear. There is no question that the vitreous was much freer from opacities than in the cases of capsulotomy. This was to be expected from the greater freedom from iridocyclitis in the cases of intracapsular operation. In general, these late results showed that if the primary result was good excellent vision was retained, as found on reexamination ten or fifteen years after operation; there were no evidences of degeneration of the vitreous or of any other lesions, and the patients had surprisingly little trouble from their eyes.

Baring of the Vitreous.—The intracapsular cataract extraction has given ophthalmologists an opportunity to study a new clinical picture, namely, the baring of the anterior surface of the vitreous body, not only in the pupillary area but in the ciliary region, and its behavior when exposed to the aqueous fluid. Many theoretic reasons have been advanced to describe the ill effects of this exposure of the vitreous; but, strange to say, such effects have not been observed clinically.

On examination in a case of intracapsular extraction, the pupillary area may be found to contain loose vitreous and the hyaloid membrane may not be identified, or there may be faint opacification of prolapsed vitreous tissue in the anterior chamber. The vitreous may protrude like a balloon and move freely. The hyaloid membrane may be definitely thinned but is thick enough to hold back the vitreous. This membrane is sometimes rather flat, or it may balloon forward on one side, where there is a synechia. Even when there is no hyaloid membrane, the vitreous sometimes bulges upward in the direction of the incision.

The bulging hyaloid membrane does not flatten out on dilation of the pupil. When the membrane is flat, there may be a number of round thin defects, like holes. The hyaloid membrane may be definite, herniated as a result of sphincter constriction and adherent to the pupillary border. In that case glaucoma may develop. Adhesion of hyaloid membrane to the section may cause glaucoma, a cicatricial transformation of the vitreous being present with distortion of the pupil. In cyclitic reactions particles of pigment are deposited on the bulging, cystic vitreous.

Excessive opacification of the vitreous prolapsed into the anterior chamber through gaps in the hyaloid membrane is sometimes observed. These masses are cloudy but do not interfere with the patient's vision and in the course of years undergo but very little change. These cloudy changes are well known in cases of capsulotomy, in which the capsular

epithelium has been held responsible, an explanation which the present observation shows not to be tenable.

Von Sallmann [68] in cases of choroidal detachment after intracapsular extraction, observed that the anterior part of the vitreous did not bulge forward but retracted posteriorly, forming a concave surface. In these cases the hyaloid membrane was situated behind the pupillary zone. This concavity was present only for a short time and might therefore escape detection.

Elschnig [69] said that after the intracapsular operation the vitreous formed a rounded, mushroom-shaped prominence which projected into the anterior chamber and was covered usually by a membrane riddled with many small holes. Free floccules of vitreous were often present in the anterior chamber, coming as far forward as the cornea.

After the intracapsular cataract extraction McDonald [70] found in 156 cases that a bulging vitreous flattened out and the hyaloid membrane did not thicken. If a tear developed, the vitreous extended forward to the cornea without damage. This observation was confirmed by others. The squeezing of the bulging vitreous by the contracted pupil might cause glaucoma. Changes in the iris or vitreous were not observed.

Carle,[71] in a review of cases four years after operation, found that vision had improved, with reduced astigmatism, and that the hernia of the vitreous into the anterior chamber had disappeared. No further displacement of the pupil had occurred; the vitreous and fundus presented no change.

Pereira [72] claimed that if the vitreous bulged into the anterior chamber, without coming in contact with the pupillary margin of the iris, no damage resulted, but that if the pupil contracted and constricted the vitreous glaucoma might result. If the pupil was very wide and the vitreous, for some reason, prolapsed into the anterior chamber, it might be caught like a mushroom and glaucoma develop.

Kwaskowski [73] found that when a hyaloid membrane was present a delicate light streak with pigment dots on the surface was detected

68. von Sallmann, L.: Spaltlampenbeobachtungen an der vorderen Glaskörpergrenzhaut nach Entfernung der Linse in der Kapsel, Arch. f. Ophth. **135**:602, 1936.

69. Elschnig, A.: Extraction of Senile Cataract in Capsule, Am. J. Ophth. **8**:355, 1925.

70. McDonald, R., in discussion on Appleman, L.: Intracapsular Cataract Extraction, Arch. Ophth. **19**:548 (April) 1938.

71. Carle, T.: After-Examination of Patients Following Intracapsular Extraction of Cataract, Acta ophth. **15**:516, 1937.

72. Pereira, R. F.: Glasskörpervorfall in die vordere Kammer und Glaukom nach intrakapsulärer Starextraktion, Arch. de oftal. de Buenos Aires **2**:409, 1926: Zentralbl. f. d. ges. Ophth. **37**:498. 1937.

73. Kwaskowski: Die Glaskörpergrenzmembran nach der Staroperation, Klin. oczna **17**:205, 1939; Zentralbl. f. d. ges. Ophth. **44**:187, 1939.

with the slit lamp. Occasionally the vitreous formed a hernia-like protrusion into the anterior chamber. This might be complicated by rupture of the hyaloid membrane, and then gelatinous masses with pigment dots on their surface might bulge into the anterior chamber. Threads might be connected with the incision and form adhesions. If iritis occurred, the hyaloid membrane became cloudy, with granular deposits, and many pigment dots were present.

Poyales and Moreno [74] said that if there was a rupture of the vitreous membrane (loss of vitreous) no partition between the anterior chamber and the vitreous space existed. Otherwise there was a curved protrusion of the intact membrane, or the membrane assumed a saclike deformation, with bulging below. A flat hyaloid membrane was unusual. Uniform bulging was ideal, and the authors found this condition most frequently in cases in which Barraquer's procedure was followed, while the most frequent destruction of the hyaloid membrane took place with the forceps extractions.

Vannas [75] could not decide whether the anterior membrane of the vitreous was a definite partition. In the presence of a rupture, vitreous substance bulged forward like a hernia. After the intracapsular extraction, the vitreous bulged forward into the anterior chamber whether the hyaloid membrane was intact or not. The author expressed the belief that a rupture might take place spontaneously some time after the operation. This late rupture has also been commented on by Woods and others. The hernia of the vitreous might vary in its degree of protrusion.

The fear of deterioration of the vitreous body, and, as a result, of the eyeball is based partly on the claim that the zonulocapsular diaphragm should be retained, as it is an important support for the internal structure of the eye. This is an important and interesting point. The retention of the vitreous body in its normal confines implies the desirability of uniform pressure on the retina, but clinical experience has failed to show any injury from the absence of this support.

Addario [76] expressed the belief that the integrity of the elastic zonulocapsular diaphragm must be preserved; hence, in his opinion all intracapsular operations were bad. The elasticity of the zonulocapsular system allowed it to exert pressure on the anterior segment of the vitreous body, so that the weight of the vitreous did not press on the ciliary processes and on the iris. It protected the ciliary processes when the

74. Poyales, F., and Moreno: Morphologie de la membrane hyaloide après extraction totale de la cataracte, Bull. et mém. Soc. franç. d'opht. **47**:211, 1934.

75. Vannas: Klinische und experimentelle Untersuchungen über die vorderen Teile des Glaskörpers, insbesondere nach intrakapsulären Linsenextraktionen, Klin. Monatsbl. f. Augenh. **89**:318, 1932.

76. Addario, C.: Il collapsus sclerae nell'operazione di cataratta, Ann. di ottal. e clin. ocul. **53**:900, 1925.

vitreous body was displaced during body movements. If the lens was completely removed, a broad communication existed between the vitreous and the anterior chamber, and the vitreous protruded into the anterior chamber. It seems to me that in this reasoning the retaining hyaloid membrane was overlooked.

Rochon-Duvigneaud objected to the intracapsular operation because of the exposure (baring) of vitreous and because prolapse of vitreous into the anterior chamber was not desirable. In his opinion, it was best to leave the posterior capsule as a protection for the vitreous.

According to Wright,[77] an eye with an intact zonulocapsular barrier was a better eye than one in which this barrier was not intact; he stated that the integrity of the vitreous must be preserved and that it was a better behaved vitreous when it was contained behind the zonulocapsular diaphragm.

CONCLUSION

The visual results of the intracapsular operation are excellent and are better than those obtained in the extracapsular operation. The operability of the immature cataract is the most important advantage of the intracapsular operation. The remarkable freedom from reaction which follows this operation is one of its most striking features.

The intracapsular extraction is undoubtedly more difficult and requires experience to meet possible complications. It cannot be stated in advance that an intracapsular operation will succeed. The operation has been much simplified and made safer by advances in certain accessory steps, such as better anesthesia, wound suture and prompt reformation of the anterior chamber. The danger of loss of vitreous is undoubtedly greater; this loss is never to be minimized, and the correct treatment of this complication is always difficult. Rupture of the capsule is also a complication that may present difficulties; in brief, complications in the intracapsular operation are difficult to deal with.

The importance of the zonulocapsular barrier for the integrity of the eye is an unsettled question, and one that requires further study. The resulting displacement and the disturbed relationship of important structures in the interior of the eye suggest the possibility of damage to the eye, but late examination of many patients and clinical experience have not shown any evidence of deterioration of the eye from this cause.

The future of the operation lies in the reduction of the difficulties with improvement in the methods of operating and with better technic; when this has been accomplished, the statement of Herman Knapp, in a letter to Colonel Henry Smith in 1905, will hold true, namely, that "If you can establish a safe method of intracapsular cataract extraction, you will equal Daviel's contribution to humanity."

77. Wright, R.: Lectures on Cataract, Am. J. Ophth. **20**:1, 1937.

MYCOTIC OBSTRUCTION OF THE NASOLACRIMAL DUCT (CANDIDA ALBICANS)

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MYCOTIC infections of the lacrimal apparatus have been recognized since their description by von Graefe, in 1854. Numerous reports may be found in the literature of various fungi producing obstruction of the lacrimal passages. Streptothrix and leptothrix are mentioned in most textbooks as the organisms commonly encountered. In the great majority of cases the obstruction has consisted of mycotic concretions in the lacrimal canaliculi. Such cases have been reported, among others, by Fazakas,[1] de Saint-Martin,[2] Carsten,[3] Talice,[4] Elliott,[5] McClanahan,[6] Reese,[7] Valière-Vialeix [8] and Brinkerhoff.[9] Reports of mycotic obstruction of the nasolacrimal duct, however, are notably lacking.

Fazakas [10] made an intensive study of the mycotic flora of normal and diseased eyes. The fungi recovered most often were Penicillium, Torula, Alternaria, Schizosaccharomyces hominis, Haplographium and

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1. Fazakas, A.: Fungi Found in the Lacrimal Canaliculi, on the Eyelids and in the Margins of the Lids, Klin. Monatsbl. f. Augenh. **104**:59, 1940.

2. de Saint-Martin: Mycosis of the Lacrimal Passages, Médecine **17**:32, 1936.

3. Carsten, P.: Fungous Concretions in the Lacrimal Canaliculi, Ztschr. f. Augenh. **62**:25, 1927.

4. Talice, R. V.: Primary Mycotic Concretions of the Lacrimal Canaliculi: Report of a Case, Ann. de parasitol. **14**:164, 1936.

5. Elliott, A. J.: Streptothricosis of the Lacrimal Canaliculi, Am. J. Ophth. **24**:682, 1941.

6. McClanahan, A.: Fungus Infection of the Lacrimal Canaliculi, Am. J. Ophth. **19**:418, 1936.

7. Reese, W. S.: Concretions of the Lacrimal Canaliculus, Pennsylvania M. J. **38**:772, 1935.

8. Valière-Vialeix: Chronic Conjunctivitis Produced by Undetected Mycelian Concretions of the Lacrimal Canaliculi: Report of Cases, Bull. Soc. d'opht. de Paris **49**:298, 1937.

9. Brinkerhoff, A. J.: Actinomycosis of the Inferior Canaliculus, Am. J. Ophth. **25**:978, 1942.

10. Fazakas, S.: Study of Fungi Cultured from Conjunctiva, Cornea, Lid Margin and Lacrimal Passages, Arch. f. Ophth. **133**:461, 1934.

Aspergillus, in descending order of frequency. Although of the fungi recovered in cases of lacrimal obstruction these forms were likewise the commonest, it cannot be assumed that they are necessarily the primary cause of the obstruction. Actinomyces is the fungus most often encountered in concretions of the canaliculi. Blastomycotic infection of the eye is extremely rare. Two cases in which Candida was present were recorded by Fazakas in a series of 404 cases of fungous infections of the eye. One of these was a case of acute conjunctivitis. In the second case the organism was cultured from an anophthalmic socket. Brownlie[11] described a case of sprue (thrush) Candida albicans) involving the lacrimal sacs, antrums, tonsils, mouth and parotid glands. The bilateral acute dacryocystitis subsided without treatment and without stricture of the nasolacrimal ducts. The infection was mixed with staphylococci and Proteus vulgaris. Search of the available literature has yielded no description of obstruction of the nasolacrimal ducts by Candida.

REPORT OF CASES

CASE 1.—A white woman aged 25, in excellent health, was seen in June 1945 for a complaint of epiphora of the right eye of about twenty-four hours' duration. General physical and special nasal examinations revealed no abnormality. Ophthalmic examination showed a normal condition except for minimal hyperemia of the bulbar and palpebral conjunctiva and moderate epiphora of the right eye. The puncta and canaliculi were normal. Pressure on the lacrimal sac produced no discharge. Irrigation through the lower punctum resulted in return of the solution through the upper punctum. As irrigation was continued the patient complained of a slight pain along the side of the nose and requested permission to blow the nose. As she did so, there appeared a cylindric cast of the nasolacrimal duct, about 16 mm. long and 3 mm. in diameter, in color and consistency resembling soft dough. The folds of the nasolacrimal mucosa were represented by shallow indentations along the cast. There was immediate cessation of epiphora, and the passage could be irrigated freely. No obstruction was present on the opposite side. Some type of mycotic obstruction was suspected. A nitrazene paper test of the tears gave a p_H of 7.3 for each eye. After the first irrigation the patient remained free from symptoms, and no other treatment was given. Three weeks after relief of the obstruction the lacrimal passages were again irrigated and the washings were collected for culture. Washings from the nose alone were also cultured. None of these showed any growth of fungi in twelve days. The patient has remained well for seven months.

Laboratory Observations.—A small, yellowish white, cylindric mass was submitted to the laboratory for examination. The mass, resembling a cast, was firm and round and tapered from one end to the other..

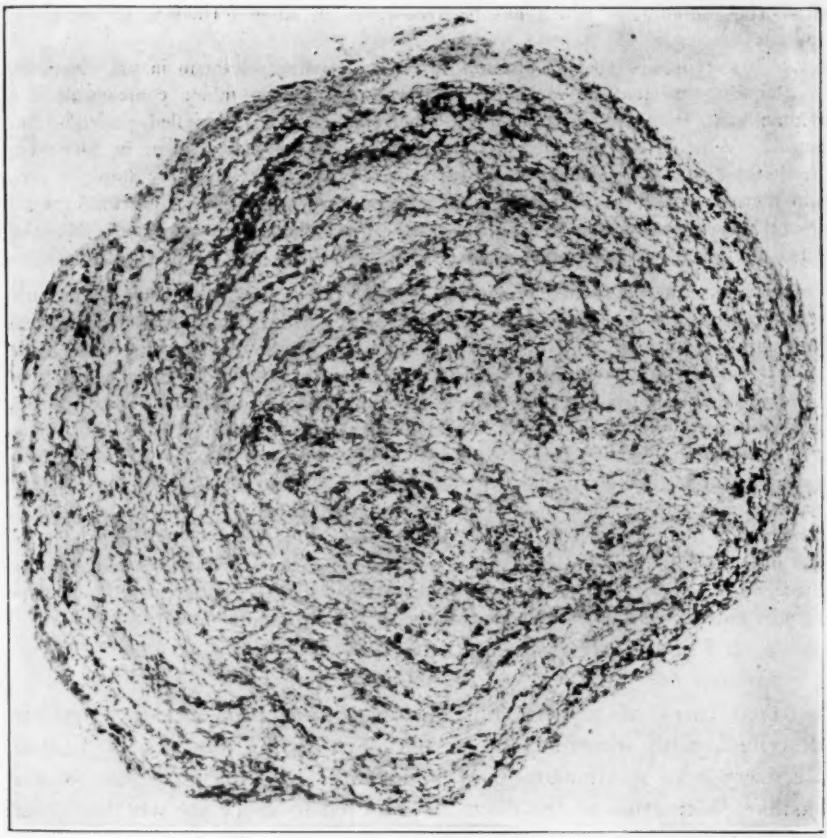
A small portion was first examined by the hanging drop method and with the Gram and dilute "carbolfuchsin" (phenol-fuchsin) stains. These preparations

11. Brownlie, W. B.: Case of Infection of the Lacrimal Sacs, Maxillary Antra, Tonsils, Mouth and Parotid Caused by Blastomyces Albicans (Thrush), J. Laryng., Rhin. & Otol. **34**:26, 1919.

showed it to be composed almost entirely of budding, yeastlike cells with a few scattered cocci and diphtheroids.

A second portion was fixed sectioned as for tissue and stained by the Gram-Weigert method. Examination revealed principally yeast cells with very little epithelial debris and a few bacteria (figure).

The remaining portion, taken for culture, was washed once in sterile istonic solution of sodium chloride to reduce external contamination and inoculated on two large tubes of Sabouraud's dextrose agar; one tube each of corn meal agar,



Cross section of cast washed from the nasolacrimal duct, composed almost entirely of yeast cells (Candida albicans).

wort agar and malt agar, and a blood agar plate. One tube of Sabouraud's agar and the blood agar plate were incubated at 37 C. and the rest at room temperature (about 25 C.).

After twenty-four hours the blood agar plate showed numerous colonies of staphylococci and diphtheriods. All other cultures showed a beginning growth of species of Candida after about three days. After incubation for a week all tubes were covered with luxuriant growth of these yeasts. Transfers were made for purposes of purification and identification according to the methods of Martin

and associates.[12] During the subsequent period of subculture it was noticed that a few colonies of an orange variety began to make their appearance. These were also subcultured with the idea that they might be mutants or a new species of Candida. Complete cultural studies showed the white species to be C. albicans, but the orange species could not be identified in our laboratory. It was therefore sent, together with the culture of C. albicans, to the department of mycology at Duke University Hospital for study. This institution reported the white species to be C. albicans and stated that an identification of the orange species could not be made except that it was a member of the fungi imperfecti and resembled a common air-borne contaminant which has been observed in slime formation during wood pulp processing.

It is our opinion that C. albicans was the causative organism in the formation of the cast and that the orange organism was either a minor commensal or a contaminant from the nose acquired when the cast was expelled through that organ. Whether C. albicans was the primary causative organism in formation of the cast or was secondary to an earlier process brought about by staphylococci, diphtheroids and other organisms or trauma cannot be stated, but there is no doubt that this yeastlike fungus caused the "mechanical" formation of the cast, since the latter was composed almost entirely of yeast cells of this type.

CASE 2.—One of us had previously encountered a similar instance of mycotic obstruction of the nasolacrimal duct. The patient, a white woman aged 49, presented the signs of subacute dacryocystitis with stenosis of the nasolacrimal duct. She gave a history of an episode of lacrimation about six months earlier which was relieved spontaneously after blowing of her nose and the appearance of a whitish, cylindric body from the nose. Repeated irrigations of the sac did not relieve the obstruction. About three weeks after the onset, as the dacryocystitis was subsiding, after another apparently unsuccessful attempt to irrigate the lacrimal passage, the patient blew from her nose a grayish white, cylindric cast, 1 cm. long and 2 mm. in diameter. There was immediate restoration of the patency of the nasolacrimal duct. Microscopic examination of the material showed it to be made up of spherical, yeastlike cells with numerous buds. Unfortunately, circumstances did not permit identification of the organism in this case.

SUMMARY

Two cases of mycotic obstruction of the nasolacrimal duct are described, with identification of the yeast as C. albicans in 1 case. Recovery was spontaneous and immediate following extrusion of the castlike obstruction of the duct. One is led to speculate whether other spontaneous cures of obstruction of the nasolacrimal duct or cures following a single probing may not have a similar explanation.

350 Post Street.

12. Martin, D. S.; Jones, C. P.; Yao, K. F., and Lee, L. E.: A Practical Classification of the Monilias, J. Bact. **34**:99, 1937.

FIELD OF VISION IN CHRONIC GLAUCOMA

A Comparison of Fields with Full and with Reduced Illumination

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IN 1931, observations on 11 cases of chronic glaucoma showing the effect of reduced illumination on the field of vision were reported.[1] The present review has to do with 50 additional cases studied by the same method.

The possibility that examination of the fields of vision with reduced illumination might reveal earlier changes is not a new idea. In his bibliography Duke-Elder [2] cited a paper by Haffmans,[3] published in 1861. Stargardt [4] had used this procedure in 1906. Ferree and Rand,[5] in 1922, suggested the advantages of taking fields at more than one intensity of illumination. In 1925 Edmund and Moeller [6] published the fields in a case of glaucoma, showing the effect of a graded series of photometric dark glasses. Traquair,[7] although he stated the belief that the use of small visual angles gives as much information, expressed the opinion that reduction of the illumination may considerably accentuate relative defects in certain pathologic conditions. In discussing darkroom perimetry, he suggested that "since impairment of the light sense is, as far as we know, the earliest symptom of impaired nerve conductivity, it is possible that there may be a field in the future for perimetry in reduced light in the diagnosis of the incipient stages of many conditions affecting the visual path." Duke-Elder [2] referred to the possibility of

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Candidate's thesis for membership, accepted by the Committee on Theses of the American Ophthalmological Society.

1. Marlow, S. B.: Visual Fields in Chronic Glaucoma: Effect of Reduced Illumination, Arch. Ophth. **7**:211 (Feb.) 1932.

2. Duke-Elder, W. S.: Text-Book of Ophthalmology, St. Louis, C. V. Mosby Company, 1938, vol. 3, p. 3384.

3. Haffmans, J. H. A.: Arch. f. Ophth. **8** (pt. 2):124, 1861-1862.

4. Stargardt, in Schieck, F., and Brückner, A.: Kurzes Handbuch der Ophthalmologie, Berlin, Julius Springer, 1930, vol. 2.

5. Ferree, C. E., and Rand, G.: Am. J. Ophth. **5**:455, 1922.

6. Edmund, C., and Moeller, H. U.: Arch. Ophth. **54**:531, 1925.

7. Traquair, H. M.: An Introduction to Clinical Perimetry, London, Henry Kimpton, 1927, p. 41.

demonstrating certain changes in the field with dim light. Passow,[8] in 1932, described a darkroom campimeter with exact regulation of light intensity. He pointed out the advantage of the method in making an early diagnosis of changes in the visual fields, especially in cases of prodromal glaucoma, and in noting the progress of the disease. Livingston,[9] in 1943, reported the application of Passow's work in the study of the field at high altitudes. Bair,[10] in 1940, confirmed the general principle that reduced illumination is desirable in studies of the fields. He attempted to vary the amount of light which stimulated the central and peripheral parts of the retina in equal amount, basing his studies on the work of Hecht.

Little attention, other than the statement that good general daylight is essential in examination of the field of vision, had been given to the effect of varying amounts of light until Ferree and Rand called attention to its importance. They showed that the variation in the amount of light on the same or on different days may result in a variability of 28 or 30 degrees in some meridians of the field. They designed a perimeter combined with a tangent screen in which a constant and even illumination of 7 foot candles was obtained. Although Duggan [11] (1940), in discussing the value of perimetry and in presenting tables for small test objects and their field limits, made no reference to the amount of illumination, he advocated noting the amount used. Thomasson [12] advocated use of artificial illumination in order that uniform results might be possible, especially when following up cases. He made no recommendation as to the amount of light desirable except to suggest that it be standardized. Quantitative perimetry has become generally accepted and more or less standardized as to the size of the test object and the distance of the screen, but not as to the intensity of illumination. The amount is seldom noted.

Whether or not the changes in the visual fields in glaucoma are due to disease of the rods or cones is difficult to determine. It is the generally accepted view that they are due to defects in the nerve fiber (impaired conduction). What part irradiation plays in bringing out early changes with reduction of illumination is hard to determine. Every nerve impulse, whether motor, sensory or proprioceptive, has the same characteristic; that is, the response is of the all or none type. It is possible, therefore, that with reduced illumination the stimulus

8. Passow: A Dark Room Campimeter with Exact Regulation of Light Intensity, Arch. Ophth. **9**:151 (Jan.) 1933.

9. Livingston, P. C.: Tr. Ophth. Soc. U. Kingdom **63**:51, 1943.

10. Bair, H. L.: Some Fundamental Physiologic Principles in Study of Visual Field, Arch. Ophth. **24**:10 (July) 1940.

11. Duggan, W. F.: Tangent Screen Scotometry: Value in Diagnosis, Prognosis and Evaluation of Therapy, Arch. Ophth. **23**:316 (Feb.) 1940.

12. Thomasson, A. H.: Arch. Ophth. **55**:545, 1926.

from irradiation may be below the threshold of stimulation for neighboring cells. The sensitivity of the test is thereby greatly increased and is therefore capable of revealing earlier defects. Whatever the explanation, it must be admitted that in the study of a case of glaucoma the more information that can be obtained from any source, the better that case will be understood. If it is true that changes in the fields are found only after the disease is established (Traquair), then perimetry as ordinarily practiced should not be expected to be of assistance in diagnosis of the incipient stages of the disease. In this early stage the fields are known to be normal. It is when the disease is in the incipient stage that changes in the fields can be brought out with the reduction of illumination when they are not demonstrable, or are doubtful, with the usual methods of examination.

The sensitivity of tests of the field of vision can be varied in three principal ways. The first has to do with variations in the size of the test object and the distance at which the test is made. The investigations of Bjerrum, Rönne, Traquair, Walker, Thomasson and Duggan are too well known to need recapitulation. The second is exemplified by the work of Ferree and Rand, who demonstrated the effect of contrast with various colored backgrounds and test objects. Wessely [13] showed that defects for red and blue can be demonstrated on the tangent screen earlier than defects for white. The third variable concerns the illumination. Combinations of these principles offer further possibilities, so that it is not possible to agree with Duggan's [11] statement that "the only way to incease the sensitivity of the perimetric test will be to increase the radius of the perimeter, since there is a practical limit to the size of the test objects obtainable." Few workers specify the amount of illumination desirable for perimetry. Ferree and Rand designed their perimeter for a uniform, constant illumination of 7 foot candles. In the clinical application of his experimental work, Bair used a neutral tint Wratten filter of 3 per cent transmission over a Bausch and Lomb tangent screen illuminator, which gives an estimated brightness of the tangent screen of about 0.003 millilambert as measured with the Macbeth illuminometer. In the present report, a brightness of 0.20 foot candle was selected because it was found that the field of normal subjects for 1/1,000 (1 mm. test object at 1 meter) was not affected by such an intensity. This intensity is close to the zone in which the rods and cones function equally.

METHOD

The patient is seated about 3 feet (90 cm.) from a wall, with two windows equidistant behind him as the source of light. The light is controlled by Venetian blinds, which are let down and heavy drapes pulled together, leaving a vertical source of light on each side of the patient. A screen similar to that described

13. Wessely, K.: Klin. Monatsbl. f. Augenh. **79-80**:811, 1927-1928.

by Thomasson (a Duane tangent screen stretched on a frame placed on a standard) is then placed at a distance of 1 meter from the patient. With a Sharp foot candle meter held close to the surface of the screen, the Venetian blinds and drapes are then adjusted to register 0.20 foot candle on the photometer. All these adjustments are made in semidarkness so as to allow time for adaptation. After the final adjustments are made, a few minutes' wait is allowed before the actual mapping of the field is begun. A 1 mm. test object is first tried. If this cannot be seen under the conditions of illumination, the smallest object that is visible is then selected for the test. If the field for this test object is small, the field of a still larger test object is plotted. Immediately after the determination and charting of the field with reduced light the test is repeated with full illumination, by which is meant that the curtains are opened as wide as possible, the amount of light available being recorded by the foot candle meter. This full

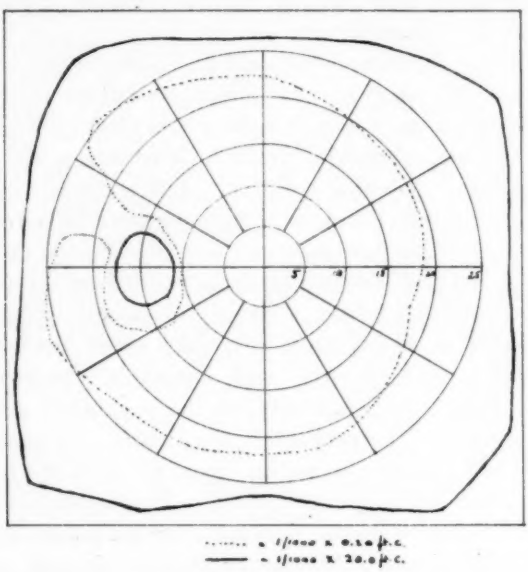

Chart 1.—Right eye; vision 6/8; tension 38 mm. Beginning of baring of the blindspot in the 1/1,000–0.20 foot candle test and some contraction of the field, as compared with a normal blindspot and full field in the 1/1,000–20.0 foot candle test. No scotomas could be detected.

illumination varies considerably, depending on whether or not the day is cloudy. Records show that it may vary from 10 to 40 foot candles. The fields under the two degrees of illumination are then compared.

OBSERVATIONS AND ANALYSIS

Charts 1 to 13 illustrate the kind of change which it is possible to detect by the reduction of the illumination in what Traquair called the preperimetric stage of the disease, as compared with the condition of the field with good illumination. Traquair [14] expressed the opinion

14. Traquair, H. M.: Clinical Detection of Early Changes in Visual Field. Arch. Ophth. **22**:947 (Dec.) 1939.

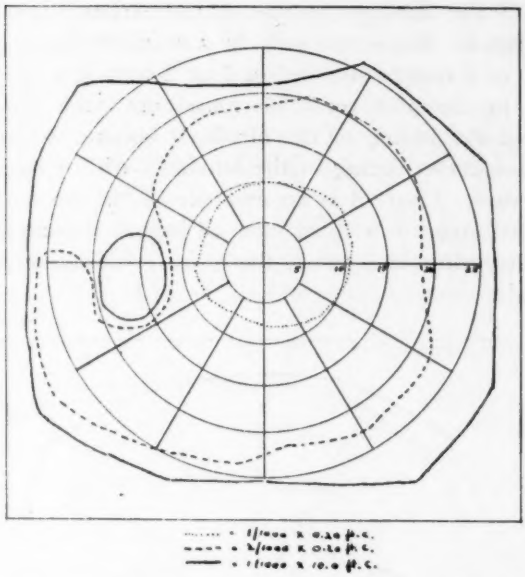

Chart 2.—Right eye; vision 6/6; tension 33 mm. Baring of the blindspot in the 2/1,000–0.20 foot candle test, the 1/1,000–0.20 foot candle field being too small. The 1/1,000–10.0 foot candle field shows slight contraction only.

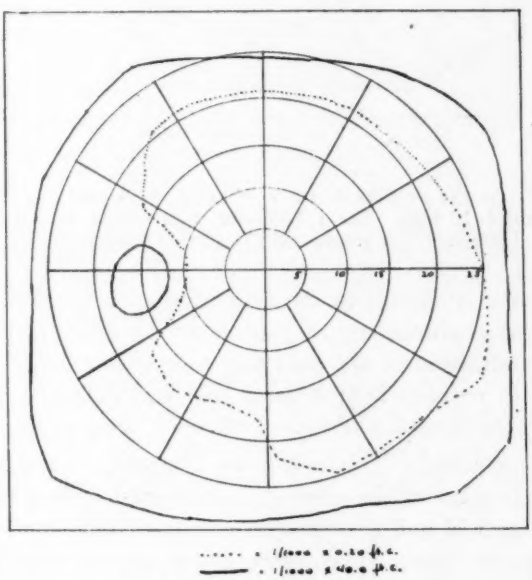

Chart 3.—Right eye; vision 6/6; tension 19 mm. More complete baring of the blindspot.

that baring of the blindspot is one of the earliest signs in glaucoma and that it can be discovered only by careful testing with the screen at a distance of 2 meters and with a 1 or 2 mm. test object. In chart 1 no defect in the field could be found until the illumination was reduced, when the baring of the blindspot became evident, as shown. Chart 2 demonstrates baring of the blindspot with a larger test object in a second case. Chart 3 is an example of the same condition at a more advanced stage in a third case. Chart 4 indicates the progress in the last case after four years, there being little change in the field with good light.

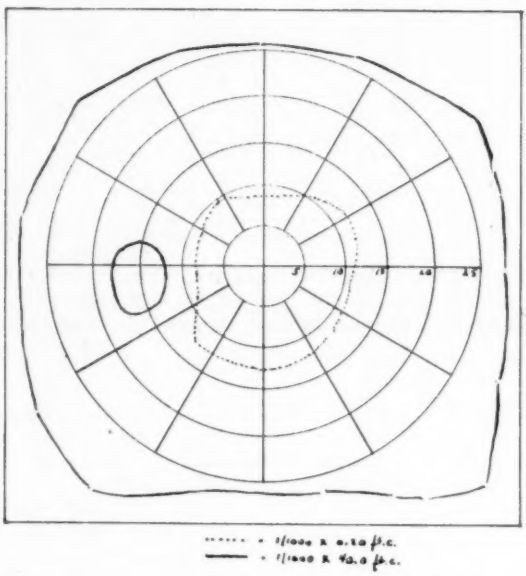

Chart 4.—Same eye as that shown in chart 3, three and one-half years later; vision 6/5; tension 12 mm. The 1/1,000–40.0 foot candle field shows no change, whereas the 1/1,000–0.20 foot candle field is further contracted.

Rönne called attention to the formation of a nasal step as one of the early signs characteristic of glaucoma. In chart 5, with full light only slight contraction of the field and a somewhat large blindspot are evident. With reduced light a nasal step was definitely outlined with the two different-sized test objects used, none being apparent otherwise.

"Arcuate scotomata," according to Traquair,[7] "may develop at a relatively early stage of the disease." In chart 6 only a moderate contraction of the field and a somewhat elongated blindspot were demonstrable in good light. The chart illustrates a greatly contracted 1/1,000–0.20 foot candle field with a typical nasal step. The 2/1,000–0.20 foot candle field is only slightly smaller than the 1/1,000–40.0

foot candle field, but an arcuate scotoma together with an enlarged blindspot could be delineated. It is of interest to note that the nasal end of the scotoma abuts on the edge of the nasal step of the 1/1,000–0.20 foot candle field. In chart 7 an arcuate scotoma without any peripheral change is shown in the 1/1,000–20.0 foot candle field. With the 1/1,000–0.20 foot candle test the scotoma is shown to be much larger, with baring of the blindspot in the lower temporal quadrant.

The relative sensitivity of the test is indicated by chart 8. In this case the 1/1,000–0.20 foot candle and 2/1,000–0.20 foot candle fields have been lost. The 3/1,000–0.20 foot candle fields is overlapped by

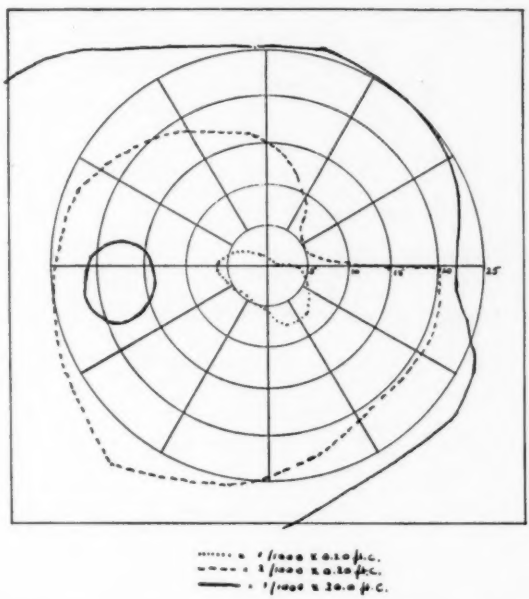

Chart 5.—Right eye; vision 6/6; tension 22 mm. No defect in the field with the possible exception of a large blindspot in the 1/1,000–20.0 foot candle test. When the light is reduced to 0.20 foot candle, the 1/1,000–0.20 foot candle field is very small, with a nasal step, which is duplicated in the larger, though contracted, 2/1,000–0.20 foot candle field.

the 1/1,000–40.0 foot candle field, which shows only moderate depression. Chart 9 is another example of the same condition. In these 2 instances the reduction in intensity of illumination to 0.20 foot candle has made the test three times as sensitive as the test with full illumination, as determined on the basis of the size of the test object used.

The greater sensitivity of the test from the viewpoint of the factor of time is well shown by comparison of charts 10 and 11. The 1/1,000–0.20 foot candle field in chart 10 is almost exactly the size of the 1/1,000–10.0 foot candle field in chart 11, taken six years later. The

evidence that progressive changes are going on, in other words, is more easily shown by reducing the light. Charts 12 and 13 further illustrate this point.

The 50 cases studied by the method described can be divided into three groups. The first includes the cases in which the duration of the disease prior to observation could be estimated from the history and in which the diagnosis was well established. There are 28 cases in this group.

The second group includes 12 cases in which the duration of the disease could not be determined either because there was no history

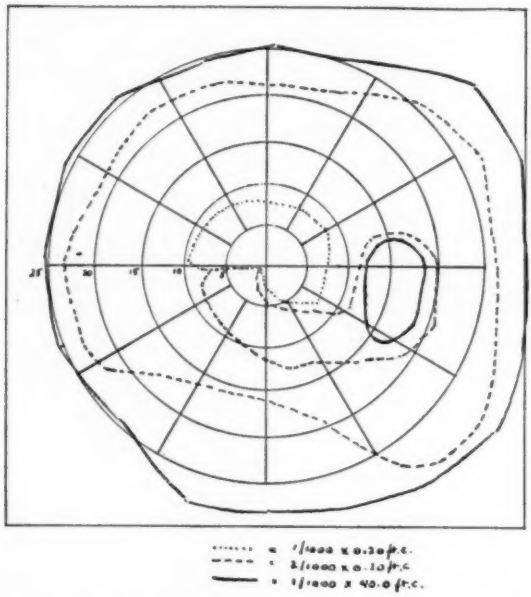

Chart 6.—Left eye; vision 6/6; tension 35 mm. No defect with the possible exception of a rather large blindspot in the 1/1,000–40.0 foot candle test. A careful search failed to uncover any scotoma. In the 1/1,000–0.20 foot candle test a very small field with a nasal step is outlined. The 2/1,000–0.20 foot candle test reveals an arcuate scotoma reaching from the enlarged blindspot to the edge of the nasal step of the 1/1,000–0.20 foot candle field. The limits of this field are also somewhat constricted.

or because the cases were studied from the standpoint of diagnosis. These cases might be said to be instances of the early stage in which the diagnosis was definitely established.

In the third group are 10 cases in which glaucoma was suspected. The method was used to prove or disprove the diagnosis. In some of these cases the condition has subsequently been found not to be glaucoma.

Analysis of the visual fields in the three groups of cases may be summarized as follows: Of the 28 cases of glaucoma of estimated

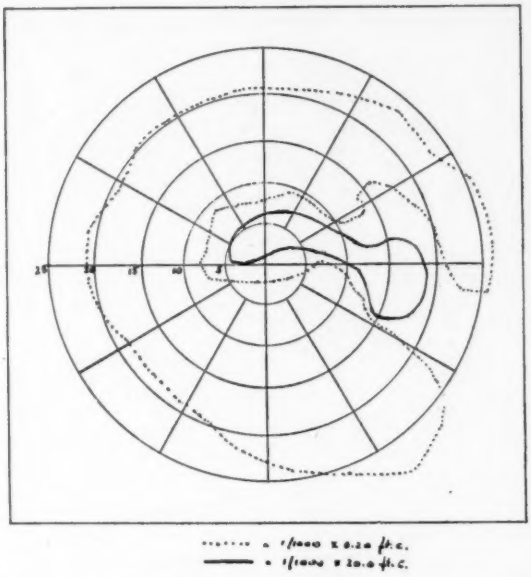

Chart 7.—Left eye; vision 6/6; tension 18 mm. Scotoma connected with the blindspot in the 1/1,000–0.20 foot candle test without any contraction of the field. The 1/1,000–0.20 foot candle test shows a much larger scotoma with baring of the blindspot below and definite constriction of the field.

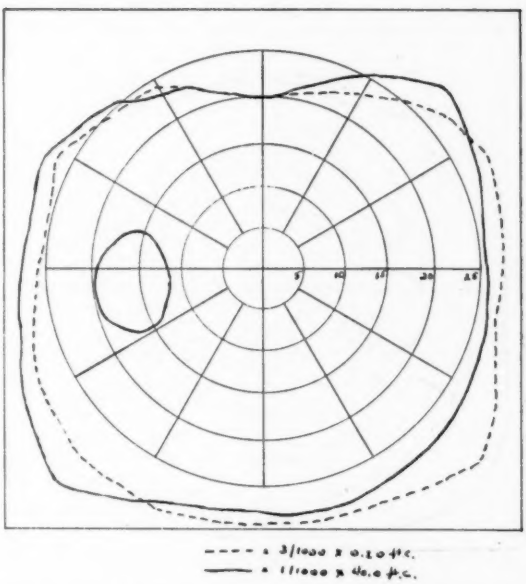

Chart 8.—Right eye; vision 6/8; tension 12 mm. Overlapping of the 1/1,000–40.0 foot candle field and the 3/1,000–0.20 foot candle field. The 1/1,000 and 2/1,000 fields with 0.20 foot candle illumination are lost. Changes have progressed so that at the time the field was taken an object three times as large was necessary to map the field. This suggests that reduction of illumination has made the test three times as sensitive.

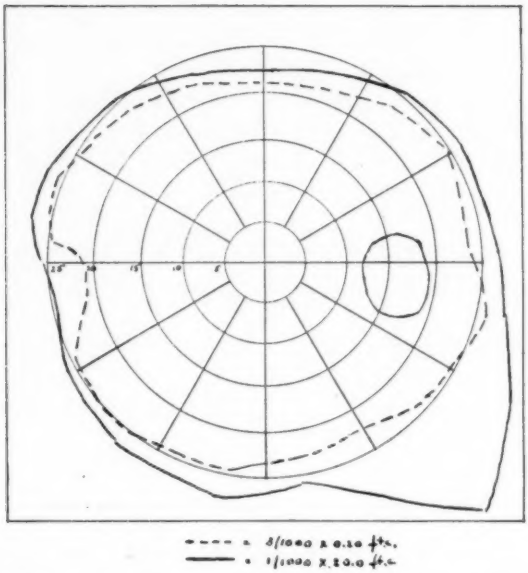

Chart 9.—Left eye; vision 6/6 +; tension 32 mm. Close correspondence between the 1/1,000–20.0 foot candle field and the 3/1,000–0.20 foot candle field. Smaller test objects were not visible with reduced light.

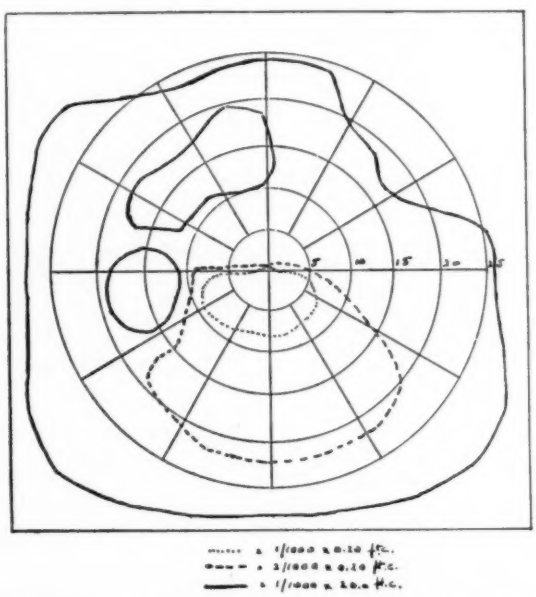

Chart 10.—Right eye; vision 6/5; tension 20 mm. The 1/1,000–0.20 foot candle field anticipates by six years the state of the 1/1,000-0.20 foot candle field in figure 11.

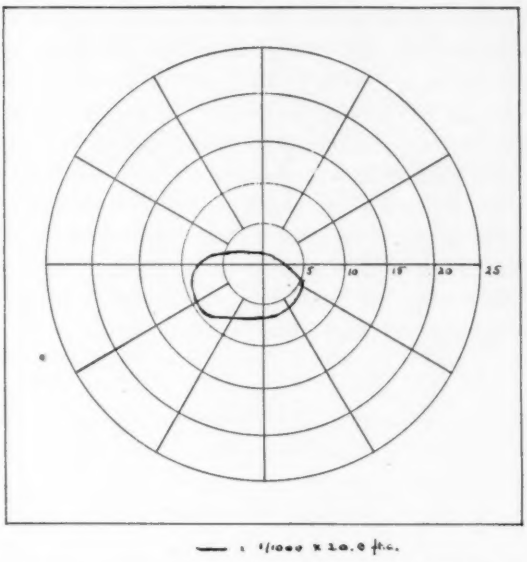

Chart 11.—Right eye two years after operation; vision 6/9; tension 19 mm. The field for this eye taken six years before is given in figure 10. The 1/1,000–20.0 foot candle field is now about the same size as the 1/1,000-0.20 foot candle field in figure 10.

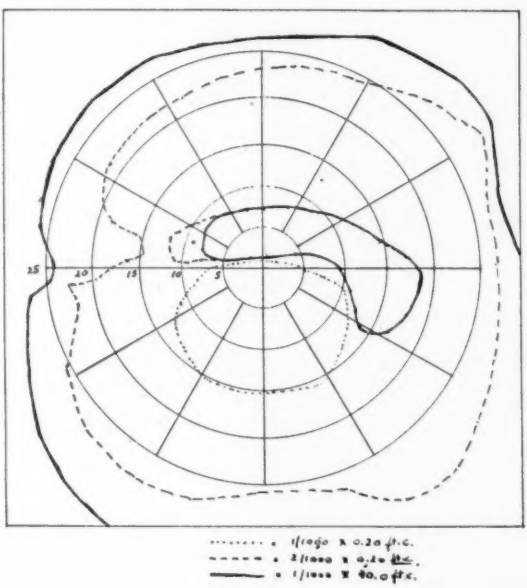

Chart 12.—Left eye; vision 6/6; tension 30 mm. Little peripheral contraction with the 1/1,000-40.0 foot candle test, but an arcuate scotoma is connected with the blindspot. The 1/1,000–0.20 foot candle field is rather small. The 2/1,000–0.20 foot candle field is almost as large as the 1/1,000–40.0 foot candle field and has an indentation directed toward the arcuate scotoma, which extends toward this area in this test, there being only a suggestion of a connection, too indefinite to outline.

duration, there were 15 in which changes were shown in the field of the better eye with reduced light only, indicative of glaucoma. Of these 15 cases, vision was as low as 6/15 in 1, 6/9 in another and 6/6 or better in the rest. Tension was as high as 40 mm. in 1 case only and was within normal limits in the rest. There was no cupping in 11 of these 15 cases. Well established glaucoma was present in the worse eye. Changes in the field of the worse eye were demonstrated with reduced light only in 6 cases. Cupping was absent in 4 of these 6 cases; tension averaged somewhat higher than in the rest of the 15 cases. These observations indicate that changes in the fields can be detected with reduced illumination before cupping and high tension are demonstrable. In the well

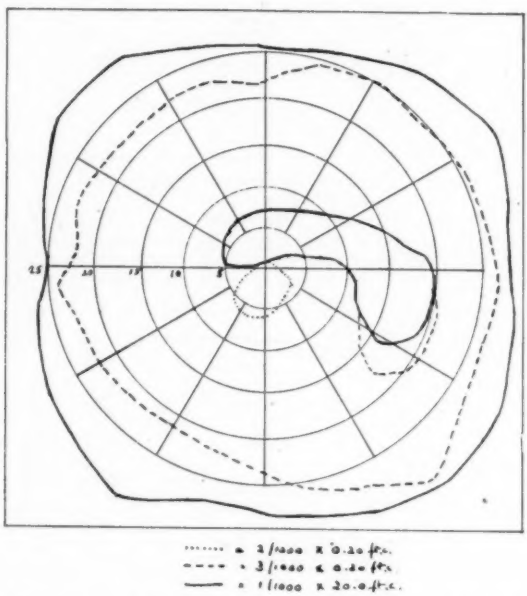

Chart 13.—Left eye; vision 6/6; tension 18 mm. Field taken six months later than that in chart 12. The 1/1,000–20.0 foot candle field is fairly full. The arcuate scotoma and blindspot have changed little. The 1/1,000–0.20 foot candle field has gone, the 2/1,000–0.20 foot candle field being much smaller than the 1/1,000–0.20 foot candle field was six months previously. The 3/1,000–0.20 foot candle field is now about the size of the 2/1,000–0.20 foot candle field in chart 13. These two fields show definite evidence of progression with reduced light, whereas with full illumination the condition of the field has changed little.

established cases of glaucoma the value of the method is greater in following the course of the disease than in the diagnosis. In the remaining 13 cases in this group the diagnosis was evident not only in the greater visual failure and the higher tension but in the more advanced changes in the fields, both with reduced and with full illumination. In these cases the method added information on the state of the disease but did not aid in diagnosis.

Of 12 cases of glaucoma of uncertain duration and a definitely established diagnosis, the field of the better eye was observed to be defective with dull light in 7, with full illumination in 1 and with both in 2, there being no contraction of any sort in 3. Of these 12 cases, vision in the "better" eye was 6/9 or more in all but 2 (6/12 and 6/15), the highest tension being 36 mm. and the lowest 12 mm. There was evidence of cupping in the better eye in 4 cases only. Vision was 6/9 or better in the worse eye in only 5 cases; tension was much higher, with cupping present, in 7 cases, 1 eye having been enucleated. In 1 case only did the field of the "worse" eye show changes with dull light alone. Three of the eyes had vision too low to permit plotting the fields, the remaining 8 eyes showing grosser changes.

In 10 cases of glaucoma of uncertain duration in which the diagnosis of glaucoma was not established at the time of examination, or subsequently, vision was better than 6/16 in all but 1 of the eyes (unilateral high myopia). Tension was within normal limits in all but 1 eye; there was no unquestionable cupping. In 15 eyes the fields showed changes in dull light not characteristic of glaucoma. In only 1 eye was there evidence of a change in field with full illumination. In these cases the changes in field found with dull illumination were not sufficiently distinct to warrant a positive diagnosis.

COMMENT

The necessity for control of the illumination in examination of fields of vision in cases of chronic glaucoma would seem obvious; yet too little attention has been directed to it. The amount of light available should be recorded, whether natural daylight or artificial illumination is used. The value of reduced light in demonstrating early field defects characteristic of glaucoma in what Traquair calls the preperimetric stage of the disease is suggested by the charts and the analysis of the cases studied.

The method used in this study was developed so that it could be available for application without the need of special apparatus except an instrument for measuring the amount of illumination, such as the Sharp foot candle meter. The use of two vertical sources of light equidistant from the screen gives a uniform illumination free from shadows. The principle can be applied by any other method, as has been done by Bair. The important consideration is the measurement of the illumination. In this study a 0.02 foot candle was selected, for the reason stated. Some other intensity, greater or less, may eventually prove to be more desirable. The method is simple and capable of application in any office or clinic.

The evidence presented here permits the conclusion that reduction of illumination is more than sometimes useful and that it is of definite

value in the discovery of incipient changes, as well as in the amplification of known or suspected defects. It is, moreover, of greater value than other methods in the demonstration of progressive changes. It is to be regretted that a comparison with the screen test at 2 meters with good light in the same case is not available. However, Traquair [14] stated that "the effect of reduction of illumination is more pronounced when the screen is used, especially at greater distances, as, for example, with a 1/3,000 or 2/3,000 test." This statement can be construed to suggest that reduction of illumination is valuable no matter what the distance of the screen.

Whatever differences of opinion may exist, it must be conceded that the illumination used should be measured and recorded.

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CENTRAL PULVERULENT (DISCOID) CATARACT AND ITS HEREDITARY TRANSMISSION

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NEWARK, N. J.

IN 1906 Nettleship and Ogilvie [1] published an extensive study of the occurrence of a congenital cataract in the Coppock family. The first observation on this familial anomaly was made by Doyne, who had the opportunity of examining the first, second and third, and possibly fourth, cases in this family between 1888 and 1896. Members of the family were affected by a definite and peculiar type of stationary congenital cataract, which showed but slight variation in clinical appearance. Most typically it was characterized by the presence of a disk-shaped opacity of steel gray color in focal light and almost homogeneous texture, though often sparkling or stippling was noticeable; the opacity made the fundus invisible or, at best, only dimly discernible. In size, shape and clearance of outline the second variety was identical with the first but was so extraordinarily faint that detection could have been missed even with the pupil dilated and the fundus readily visible. In the third variety, the diameter of the disklike opacity was less; its outline, though circular, was slightly irregular or eroded, and the texture, though translucent, was granular. The type of the disk-shaped opacity was not fixed in all instances in which parent and children were affected or in the affected members of the same sibship. Thus, V-11 had the third, or small, variety with irregular outline, his daughter (VI-38) exhibited the first, or large dense, form; the younger daughter (VI-42), the second, or transparent, variety; again, a woman (IV-10) and her youngest child (V-31) were afflicted with the first variety, while her 2 oldest children (V-26 and V-28) showed the third form, designated as such by the authors.

The cataract was always bilateral and symmetric in the two eyes of the same person; it was stationary, without any signs of progressiveness; the youngest patient was 10 and the oldest 82. The large type of disk was of sufficient size to obstruct the ordinary pupil of 4 mm. diameter. The classification by competent observers varied from a small lamellar opacity to an opacity of the posterior capsule. Nettleship and Ogilvie observed only a single layer of opacification; the layer itself was always thin but of varying degrees of transparency, and was

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1. Nettleship, E., and Ogilvie, M. F.: A Peculiar Form of Hereditary Congenital Cataract, Tr. Ophth. Soc. U. Kingdom **26**:191, 1906.

situated behind the nucleus but well in front of the posterior capsule. Although regularity and sharpness of outline were suggestive of lamellar opacity, the evidence of the presence of a second layer, either in complete form or in the form of riders, could never be furnished, and therefore the opacity was distinctly different from lamellar cataract. The authors went a step further in emphasizing the difference between this cataract and the lamellar type by stating that the opaque disk cannot be the representative of a lamellar cataract with coalesced layers after absorption of the center, for then the opacity would be confined to the nucleus; observations with the parallactic test and focal illumination, however, agree in placing the disk definitely behind the nucleus. Localization behind the nucleus antedated by many years the accurate localization made available through the use of the slit lamp and was based on methods available at the time of the study. These methods, needless to say, were much inferior and were almost archaic as compared with the accuracy of localization afforded with the use of the slit lamp, a fact which will be discussed at greater length in a later section.

Members of the family with multiple occurrence of the disk-shaped opacity were described as of healthy stock, bright, intelligent, over the average in height and girth and exceeding the average in duration of life; rickets and syphilis were absent; the teeth were good, and there were no physical anomalies. One epileptic person was found among 300 members of the family noted. Similarly, in other large family trees showing the anomaly, no physical deviations from normal were observed; only Rosen [2] mentioned the association of camptodactyly with the cataract in 1 case. Camptodactyly has occasionally been mentioned with other forms of congenital cataract, such as the floriform type. The simultaneous occurrence of cataract and anomalies of the fingers was noted, but the genetic linkage is unexplained and, according to Waardenburg,[3] is often more than doubtful. Visual acuity was not much lowered because of the condition.

Of the two original pictures, presented by Nettleship and Ogilvie,[1] the first presents the typical variety, a circular, somewhat conical, opacity at 5 o'clock; the second, an atypical form, with perfectly circular outline and a triradiate opacity of greater density than the rest. The triradiate figure was evident in only 1 opacity; 2 or 3 others showed only a slight indication of it.

In the same year (1906) Levy [4] reported a case in which, in the center of each lens, in the position of the nucleus or immediately behind

2. Rosen, E.: Coppock Cataract and Cataracta Pulverulenta Centralis, Brit. J. Ophth. **29**:641, 1945.

3. Waardenburg, P. J.: Das menschliche Auge und seine Erbanlagen, Haag, Nijhoff, 1932.

4. Levy, A.: Unusual Congenital Opacities in Both Lenses, Tr. Ophth. Soc. U. Kingdom **26**:74, 1906.

it, a circular opacity of 3 mm. diameter, with clearcut edges, yellowish amber color and somewhat granular appearance, was visible.

Nettleship,[5] in a second paper published two years later, proposed the designation of "Coppocks cataract" for working purposes and that of "discoid (Doyne) cataract" for descriptive purposes. Whereas in the original paper dealing with the Coppock family the anomaly was described as a distinct entity, differing from the lamellar variety, in the second paper a pedigree was presented in which lamellar cataract, discoid cataract and retinitis pigmentosa (pigmentary degeneration of the retina) affected various members of the same family; some discoid cataracts in this series were not large enough to block the pupil; other opacities, described as lamellar, reached 4 mm. in diameter, and others exceeded even that diameter. Of the 32 congenital cataracts, 24 (16 in males and 8 in females) were designated as lamellar and 8 (3 in males and 5 in females) as discoid. The pedigree showed 275 persons (110 males and 115 females with the sex of 50 unrecorded). All the members were the descendants of 2 brothers and their respective wives.

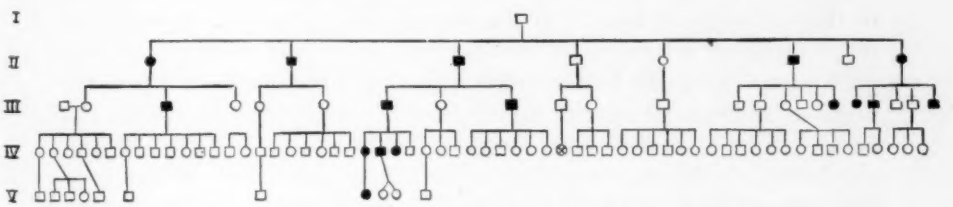

Fig. 1.—Pedigree of Nettleship and Ogilvie, showing central pulverulent (discoid) cataract.

In this figure, and in the accompanying figures, hollow squares indicate males not examined; hollow circles, females not examined; black squares, affected males, and black circles, affected females.

The pedigree was divisible into two parts, the larger portion (180 persons) consisting of the members afflicted with cataract, and the smaller portion (150 persons) including the members with retinitis pigmentosa (15 persons), the two conditions overlapping to a slight extent in some cases. The two conditions were not causally related, each having been introduced by a different ancestor from an independent source. All cataracts were traceable to the 2 brothers; the retinitis pigmentosa was found only in the descendants of 1 of the 2 brothers and was brought in by his wife, for whom the data are outstanding. The sex incidence and the mode of inheritance of the two diseases were different. Cataract affected more males (19 males and 13 females) and was usually

5. Nettleship, E.: Lamellar Cataract: Coppock or Discoid Cataract and Retinitis Pigmentosa Affecting Different Members of the Same Family, Tr. Ophth. Soc. U. Kingdom **28**:226, 1907-1908.

transmitted through the father (the affected father in 6 cases and the unaffected father in 1 case); it was transmitted through the affected mother in 1 or 2 cases, through the unaffected mother in 2 cases and through both parents in 1 case. The descent was continuous except in 2 cases. Retinitis pigmentosa, similarly, affected more males (13 males and 3 females), but the descent was without exception a discontinuous one and was transmitted through the unaffected mother. The collocation of discoid cataract with the ordinary lamellar variety was the outstanding phenomenon, presenting itself in two sets of cousins, in 2 brothers and in a brother and sister (III 28 and 30 and IV 50 and 56, respectively).

In his Bowman lecture, Nettleship [6] described the discoid opacity as occupying only a small fraction, possibly one twentieth or less, of the entire lens. He stated that the malign influence, whatever its nature, acts on the lens in the earliest stage of its development, possibly even before the closure of the lens cup, and the range of action is so limited as to damage no other part of the epiblast, or any part of the mesoblast other than the minute portion concerned in the nutrition of the rudimentary lens. On the basis of the pedigrees, showing the more frequent transmission through the male, the influence of the male parent seems to be the more important. Nettleship reversed his previous opinion, presented in collaboration with Ogilvie, which was based on the pedigree of the Coppock family, and stated that discoid and lamellar cataracts were identical anomalies, not independent forms. He asserted that the discoid cataract is the smallest possible variety of the lamellar type, so minute that two layers are united or indistinguishable, the position of the disk, or flattened lamella, at a deeper level than the nucleus of the normal lens, but well in front of the posterior capsule, remaining without satisfactory explanation. In other words, Nettleship did not change his opinion about the localization; he concluded only that discoid, or Coppock, cataract was not a distinct entity, but purely a smaller variety of the lamellar cataract. In accordance with this view, the lamellar cataract may be prenatal or postnatal, the hereditary form developing toward the end of fetal life. The diagnosis of lamellar cataract was made definitely by Horner in the case of a child 6 weeks of age, but has been made as early as two weeks after birth. The size of the lamellar cataract is intimately connected with the time at which the lesion acted on the lens, the diameter of the lens being 3.3 mm. in the fourth month, 4.5 mm. in the sixth month and 5 mm. in the seventh month, of fetal life, reaching 7.5 mm. at birth. An opacity measuring 6 mm. must, necessarily, have developed after birth because it corresponds to a lens of 7 mm., the

6. Nettleship, E.: On Some Hereditary Diseases of the Eye (Bowman Lecture), Tr. Ophth. Soc. U. Kingdom **29**:lvii, 1908-1909.

diameter before the shrinkage of the nucleus, which represents the first stage of formation of the opaque perinuclear layer.

In the American literature, Chance [7] (1907) was the first to report opacities of the lens like those described by Nettleship and Ogilvie, the cataract occurring in a father, 3 of his 5 sons and his only daughter. The opacities were of the same kind in each instance and measured about 4 mm. in diameter; they were bilateral and without exception accurately symmetric in the two eyes. The author's description, however, does not correspond with the plates in his paper. For instance (figure 2 in plate XI), the opacities in the father's eyes are of similar nature but not accurately symmetric, the opacity in the right eye having a horizontal reniform shape, with a hilus at the lower border, and the opacity in the left eye being almost circular, with flattened base. The cataracts appeared to be stationary; the disks were of almost the same thickness, and the localization was that given in the previous reports. The color corresponded to that of boiled sago, and the disk was of minutely granular consistency and was

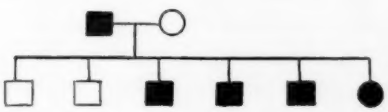

Fig. 2.—Chance's family with discoid cataract in both eyes of the father and of 4 of his 6 children.

translucent. In 1 of the cases in this family, clumps of opacities appeared in one eye, and the denser masses formed an indefinite star in the lens of the other eye. In 1 of the cases the disk was extremely thin, as though the result of simple condensation, whereas in the last case circular vacuoles were noted.

Smith [8] observed the cataract first demonstrated by Doyne in members of a family not related to the Coppocks. He described it as discoid and retronuclear and as varying in size in different members of the family; the very slight, lamellar opacity was not observed. The youngest affected member was 3 and the oldest 64 years of age. Harman [9] described the opacities as small and close to the nuclear region; in cases in which definite lamellar structure was observed the opacity was small in relation to the total size of the lens, sharply defined and without riders.

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7. Chance, B.: Unusual Form of Hereditary Congenital Cataract in Several Members of a Family, Arch. Ophth. **36**:505, 1907.

8. Smith, P.: A Pedigree of Doyne's Discoid Cataract, Tr. Ophth. Soc. U. Kingdom **30**:37, 1910.

9. Harman, B.: Congenital Cataract: Pedigree of Five Generations, Tr. Ophth. Soc. U. Kingdom **29**:101, 1909.

The first to describe this form of cataract was Doyne, who examined the oldest members of the Coppock family; almost twenty years later the same family was the subject of extensive study by Nettleship and Ogilvie. Soon it became evident that the anomaly did not occur in the descendants of the Coppocks only, as the family reported by Smith was in no way related to the Coppock family. "Doyne's discoid cataract" was suggested as a distinctive name for this congenital defect, for the term "disk-shaped cataract" had already been applied to another form of congenital cataract (in which the nucleus was entirely lacking and the lens was represented by a flattened, disklike structure, shaped like a dumbbell, with opaque central portion and clear periphery), and the name "Coppock cataract" is objectionable because it labels a congenital defect with the name of one family which presented the hereditary form of the anomaly.

The English and the American literature as reviewed contained numerous observations on the anomaly described. After the introduction of the slit lamp, the first description of a congenital form of cataract was that of Vogt,[10] the author designating it as "cataracta pulverulenta centralis." In his first publication, Vogt stated that there was no similar observation in the entire ophthalmic literature except for a case reported by von Hess as one of lamellar cataract, in which the opacity was only 2 mm. in diameter, and therefore probably of similar nature to that in his case. The central nucleus of the opacity was given as 0.72 mm. and the peripheral ring as 1.04 mm. in diameter. Both sections were sharply outlined, the dots appearing delicate and surrounded with a light ring and the opacity being located in the space between the anterior and the posterior suture. The part of the lens to be affected is the embryonic nucleus, and therefore the oldest part, and the opacity necessarily develops in the first months of fetal life. In the central part the dots exhibited a radial arrangement; there were larger dots, measuring 0.1 mm. Peripheral to the outer ring, and about 3 mm. from it, traces of a third ring of the opacity were discernible. In the first edition of Vogt's "Atlas" there is an excellent picture; the equatorial diameter of the entire opacity is given as 2.2 mm., the central, denser, opacity measuring 0.8 mm. The embryonic sutures were not visible. The opacity, probably congenital, was composed of dustlike and punctate dots; the central, opaque nucleus was more rounded in the saggital direction than the less dense layer peripheral to the nucleus (fig. 235 *c* and *d*). In the second edition of his "Atlas," [11]

10. Vogt, A.: Atlas der Spaltlampenmikroskopie des lebenden Auges mit Anleitung zur Technik und Methodik der Untersuchung, Berlin, Julius Springer, 1921; Arch. f. Ophth. **107**:196, 1922.

11. Vogt, A.: Lehrbuch und Atlas der Spaltlampenmikroskopie des lebenden Auges, Berlin, Julius Springer, 1931, vol. 2, p. 438.

3 cases are illustrated (1 of which is identical with the case in the first edition) showing the apparent increased density of the equator (figs 967 *a* and *b*, 968, 969 and 970). In the new cases there were a few larger opacities in the form of large white dots; furthermore, the circumference was not strictly circular; one opacity showed a slight bulging in the directions of 6 and 7 o'clock. If one compares this opacity with the conical opacity described in the first case, the typical picture of Nettleship and Ogilvie, one finds them extremely similar. When one compares the pictures presented by the two authors the similarity is more than striking. The circular, sharply marked outlines; the slight conical form, directed downward; the dustlike, gray, dense opacities, and the absence of larger clumps are identical. One wonders whether there can be any other explanation than that offered by the two authors, belonging to different language groups and unaware of the fruits of each other's labor. Based on the description of the new form of cataract given by Vogt, a series of articles appeared on the morphologic character of central pulverulent cataract in the German and Italian literatures (Poos,[12] Rauh,[13] Hanssen,[14] Peterdy,[15] Favaloro,[16] Russo[17]), in which the authors took it for granted that the anomaly in question had never been observed prior to Vogt's publications. The vast English literature was entirely overlooked, in spite of the fact that Gifford,[18] as early as 1924, pointed out that examination with the slit lamp in the older cases would have proved that the affected part was actually the embryonic nucleus and that the opacity would fall into the class of "congenital embryonal nuclear cataract" (as disclosed by the slit lamp, with a small beam of lamp) described by Vogt. The publication of Gifford, which will be discussed later in more detail, was overlooked again, possibly because of its being published in English. At this point attention must be directed to the fact that Gifford treated the same subject in a second paper (1927), this time written and

12. Poos, F.: Ueber eine familiär aufgetretene besondere Schichtstarform: "Cataracta zonularis pulverulenta," Klin. Monatsbl. f. Augenh. **76**:502, 1926.

13. Rauh, W.: Doppelseitige Cataracta pulverulenta mit symmetrischer Nebentrübung, Klin. Monatsbl. f. Augenh. **83**:38, 1929.

14. Hanssen, R.: Beiträge zur pathologischen Anatomie der Linse (Cataracta pulverulenta), Ztschr. f. Augenh. **76**:73, 1932.

15. Peterdy, E. M.: Sulla cataratta zonulare pulverulenta, Arch. di ottal. **36**:35, 1929.

16. Favaloro, G.: Cataratte embrionali e fetali, zonulari, centrali (contributo clinico e biomicroscopico), Ann. di ottal. e clin. ocul. **64**:721, 1936.

17. Russo, A.: Contributo alle cataratte congenite, ereditarie e familieri sulla cataracta centralis pulverulenta, Ann. di ottal. e clin. ocul. **63**:105, 1935.

18. Gifford, S. R.: Congenital Anomalies of the Lens as Seen with the Slit-Lamp, Am. J. Ophth. **7**:678, 1924.

published in German,[19] but the authors were still unaware of the facts pointed out by Gifford.

Poos [12] observed the anomaly in the lenses of both eyes of a mother and 4 daughters (the fifth child, a son, was not examined). In the mother's case the cloudy area measured about 2 mm.; only one concentric layer was affected; the center and the periphery of the lens remained transparent. The cloudiness was denser at the periphery and diminished toward the central part. The opacities were dustlike, punctate and powderlike, with a distinct regularity; the size of the individual opacities increased toward the periphery. In the oldest daughter the cataract showed the same texture, but the opacity measured 3.5 mm. The principal zone of cloudiness was surrounded peripherally by a second layer of more delicate opacities. The demarcations toward the equator and, similarly, toward the anterior and posterior bulging surfaces were extremely sharp. The opacity in the case of the second daughter strongly resembled that in the previous case, except that here there was a larger, irregularly shaped, opacity in the center of each lens, a feature which was lacking in the other members of the family. The lenses of the third daughter showed the characteristic opacity, with the difference that the main zone of the opacification was denser and the external ring extremely faint. In the case of the youngest daughter the opacities were very delicate and occupied only a single layer. The pictures were identical in the two eyes of the same person.

The multiple layers of cloudiness are common to the lamellar type of cataract, but they differ in the minuteness and regularity of the component elements; furthermore, in the absence of radial opacities, the riders, which are so characteristic of the perinuclear cataract, are not present. Poos identified the cases with those described by Vogt but pointed out that in Vogt's presentation the center of the lens showed an even denser accumulation of the minute dots and that in his (Poos's) cases, with 1 exception the center was as free from the opacities as the clear periphery. The opacities in Poos's cases were in multiple layers; considering this arrangement, he proposed the designation cataracta zonularis pulverulenta.

In the case of Rauh [13] the opacity did not show the characteristic picture. He observed in the lenses a delicate, spherical opacity consisting of extremely minute, white dots, with some greenish or reddish shimmering in the central part. The density of the opacity was greatest in the central portion and diminished toward the equator, which was not sharply defined. The opacity occupied the site of the embryonic nucleus; the posterior sutures were well defined, and the anterior sutures

19. Gifford, S.: Zum kongenitalen Star des Embryonalkerns, Klin. Monatsbl. f. Augenh. **78**:191, 1927.

were hardly discernible. The zones of discontinuity of the embryonal nucleus were sharp. The central opacity disclosed a visible interval, producing the appearance of a central opacity surrounded by a wide saucer. Downward from the embryonic nucleus in each lens, and symmetrically located, was a second distinct, small round opacity enclosed in a homogeneous layer but isolated from it by a clear zone consisting of dots identical with those in the larger spherical opacity of the embryonic nucleus. This second (small) opacity was within the zone of discontinuity of the embryonic nucleus. The anterior and posterior cortical layers contained a few punctate opacities. The small opacity in the lower part of the lens, the punctate structure of which was identical with that of the primary, large opacity of the embryonic nucleus, deserves special consideration, because in zonular opacities the lamellar nature always discloses parallelism, not only of the lamellas but even of the isolated opacities; the riders are concentric with the center of the lens.

It is questionable whether the case of Hanssen,[14] cited solely because of its being the only case in which histologic examination could be reported, really belongs to the group under discussion. The author himself considered the possibilities of zonular, or central pulverulent, cataract, or of the senile premature punctate cataract of Becker or of a juvenile cataract progressing through senile changes. Both lenses were affected in his case, but in very different degrees (vision was 4/6 in the right eye with a correction of —3.50 D. and was limited to counting fingers at 1 foot [30 cm.] in the left eye). The central opacity consisted of powder-like dots; a narrow, but clear, ring of cortex was sharply differentiated from the cloudy central area. Cloudiness extended into the periphery; the fundus was visible only with maximum dilatation of the pupil. The delicate cloudiness was most pronounced at the periphery but was also present throughout the entire nucleus. The left lens was extracted intracapsularly, and section through the center revealed clear cortex, sharply demarcated toward the center, which contained numerous small, cloudy dots, becoming less dense toward the center. Under high magnification, small empty spaces of various configurations, round, oval, angular and irregular with granular content, were seen. The average space measured 8 to 15 microns; some were larger, with septum-like divisions. In the periphery of the cloudy portion the outlines of the lens fibers were indistinct, and at times invisible; they were in better state of preservation toward the center; with wavy outlines and empty spaces between the fibers. Lime salts were not present; examination for lipids was not possible.

The features of the case do not justify classifying the anomaly as a central pulverulent cataract; histologic examination of the latter form of cataract has not been made, which is not surprising considering that it represents a nonprogressive anomaly, causing only slight visual disturbance.

Omitting the casuistic publications of purely descriptive observations, one must consider again the work of Gifford, which presented for the first time the connecting link between the material gathered in the relatively older English literature and the more or less recent German literature, stimulated by Vogt. Duke-Elder [20] described the discoid cataract and stated simply that the appearance with the slit lamp had been described by Vogt. With the ophthalmoscope, Gifford observed in his patient, a woman aged 54, a circular, sharply circumscribed opacity, 2 mm. in diameter, in the center of the pupillary area of each lens. The opacity was not very dense; the fundus opacity corresponded to the anterior surface of the embryonic nucleus; the anterior and posterior sutures were invisible. The opacities consisted of white dots of varying sizes, surrounded individually by a brighter ring; the denser central area was relatively larger than in the first case of Vogt, and there was no differentiation of a shell separated by a clearer layer from the denser central portion. The keen observation of Gifford led him to the conclusion that the central pulverulent cataract described by Vogt is identical with an anomaly observed in England and in the United States and designated as Coppock cataract, Doyne's discoid cataract or familial nuclear cataract. The diagnostic criteria are the size of the opacities, their texture and their exact location within the lens. The first two did not escape the attention of the older observers, whose armamentarium consisted only of focal illumination and the parallactic phenomenon, and the employment of the slit lamp gave Vogt and later observers the possibility of localization within the embryonic nucleus. In his second paper (published in German) Gifford reiterated his opinion as to the possible identity of Vogt's cataract with the type described in the English literature, a consideration emphasized for the first time but, nevertheless, totally ignored in the German literature, even in the second edition of Vogt's "Atlas," which appeared many years later. The second paper of Gifford contains interesting data; in 1 of the 4 typical isolated cases the patient had a son with perinuclear cataracts, a relation similar to that existing between the two forms reported previously by Nettleship and Harman. In 1 family the mother and daughter were similarly afflicted, but the opacity was somewhat larger, about 3 mm. in diameter, with visible anterior and posterior sutures, as described by Vogt.

Morphologically, this anomaly of the lens affects the ontogenetically oldest part, the embryonic nucleus, and is a true idiokinetic malformation. The diameter of the opaque zone, which often represents a double line, varies within certain limits, measuring on the average from 2 to 4 mm.

20. Duke-Elder, W. S.: Text-Book of Ophthalmology, St. Louis, C. V. Mosby Company, 1938, vol. 2, p. 1368.

Members of the same family afflicted with the anomaly present opacities of various sizes. Poos reported that in the case of the mother the opacity measured approximately 2 mm., the equivalent of the outer zone of the embryonic nucleus, and in the 4 daughters the central zone was twice this size, with a second zone of cloudiness, of still larger diameter, in 3 of the 4 cases. Two cases of Vogt were similar to the cases of Poos, the opacity in the first affecting the embryonic nucleus and that in the second showing two zones of more diffuse opacities around the central zone, similar to that in the third case of Poos. Nettleship and Ogilvie, who observed the largest number of cases within a single family, emphasized the presence of only slight variations and gave an excellent clinical description of the three varieties; they recognized the possible variation of the types in parents and children, or among affected members of the sibship. Vogt, in a much smaller number of members of the affected family observed that the hereditary anomaly was identical, not only in size and location of the opaque zone but in the outlines and texture of the cloudiness, the double contour and the minute dots with the presence of larger elements. The latter assumption seems to be in diametric disagreement with the literature (Nettleship and Ogilvie, Chance, Poos and others) and with the findings in a family which I observed. The central pulverulent cataract is always bilateral and identical in the two affected lenses of the same person except for the slightest individual variations. The bilateral appearance is important, considering the resemblance of the structure to a zonular arrangement and the possible relation, therefore, to zonular cataract and the possibility of transitional forms between the two types. The early observers in the English literature described a single layer of opacification, but the advent of the slit lamp proved in many cases the presence of a second, or even a third, ring of dots encircling the central opaque zone. Poos suggested the designation of cataracta zonularis pulverulenta, Russo, that of a central pulverulent opacity. Similarly, Bellows [21] observed a case with numerous fine dots of equal size in the embryonic nucleus surrounded by a concentric, peripheral ring of hooklike, radial opacities. The proximal portions of the hooks appeared to be wider than the distal, presenting angular opacities (riders) in association with the central pulverulent cataract. Nettleship and Harman pointed out the alternating occurrence of the two types in the same family, and, similarly, Gifford reported a case in which the son has been operated on for zonular cataract.

Even in the complicated cases, in which the cataract is associated with coralliform cataract or with cataracts of other types, occurrence is

21. Bellows, J. G.: Cataract and Anomalies of the Lens, St. Louis, C. V. Mosby Company, 1944.

always bilateral. Mann [22] stated that zonular cataract is bilateral, but other authors, such as von Szily,[23] were undoubtedly not mistaken in their opinion that the typical zonular cataract occasionally appears as a unilateral lesion. I recall few cases of unmistakably unilateral lamellar cataract in young children; true, this type may be hereditary or acquired, and the possibility of proving the presence of unilateral hereditary cataract of this type has not yet been investigated. The question of such a possibility will be the task of future observation and research. From the standpoint of modern genetics, one must consider the possibility, as known hereditary anomalies, such as polydactyly, ptosis of the upper lid and coloboma, may occasionally show unilateral manifestation.

In the second family of my observation, the complicated form of central pulverulent cataract was, accordingly, present in both eyes of the members so affected. To my knowledge, there is no proof in the literature of the presence of unilateral appearance.

The sharply defined area consists of minute dots in the embryonic nucleus, surrounded by a slight halo. Occasionally larger dots are mingled with the minute ones. The opacity may be steel gray and densely stippled, or very thin and translucent, or very small and granular; the process is not progressive and remains unchanged throughout life. In young children and in old persons the morphologic character does not undergo any variation. The visual disturbance is usually slight, Jess [24] being the only one to describe the visual disturbance as considerable. The early observers described the cataract as a flat disk situated between the nucleus and the posterior pole, but always separated from the latter by clear cortical layers. The true morphologic character was not disclosed before the employment of the slit lamp, when the biconvex appearance, involvement of the embryonic nucleus and the multiple layers of dots became generally known. In this connection, it is of interest that Adams [25] had the opportunity to examine 1 member of the Coppock family with the slit lamp. In this patient the opacity was a fairly dense, spotted, circular disk, the slit lamp disclosing its biconvex nature, with involvement of the embryonic nucleus. The minute dots appeared white in the beam of the slit lamp, with a more or less clear central area. The anterior and posterior sutures could not

22. Mann, I.: Developmental Abnormalities of the Eye, London, Cambridge University Press, 1937.

23. von Szily, A.: The Contribution of Pathological Examinations to Elucidation of the Problem of Cataract (Doyne Lecture), Tr. Ophth. Soc. U. Kingdom (pt. 2) **58**:595, 1938.

24. Jess, A.: Die Erkrankungen der Linse, in Schieck, F., and Brückner, A.: Kurzes Handbuch der Ophthalmologie, Berlin, Julius Springer, 1930, vol. 5, p. 201.

25. Adams, P. H.: Doyne's Discoid Cataract (Coppock), Brit. J. Ophth. **26**: 152, 1942.

be definitely identified. According to Adams, the nature of the opacity was that of a very small lamellar cataract, a finding which appears fairly often. Bursuk [26] expressed the belief that the central pulverulent cataract was a *forme fruste* of the zonular type.

The size of the opaque disk varies. Mann, who did not mention central pulverulent cataract, but spoke only of disciform, or Coppock, cataract, stated that it must form at or before the sixth month of fetal life. Bellows [21] simply reproduced Mann's table of the times of appearance of abnormalities. It seems that the varying size of the opaque disk means the formation at different periods. In his Bowman lecture,[6] Nettleship pointed out, with regard to the lamellar cataract (page 60), that the size of the cataract is indicative of, and in direct association with, the time the lesion has acted on the developing lens. The smaller the opaque area, the earlier was the time of action which resulted in the anomaly. Gifford applied the same principle to the central pulverulent cataract, stating that in the small variety affecting solely the embryonic nucleus the origin of the anomaly must be placed as early as the third month; consequently, the larger zone of opacity indicates, accordingly, a later time for the action of the lesion, possibly the fifth or the sixth month of fetal life.

The original observation on the type of cataract in the Coppock family showed a dominant mode of inheritance, which is almost the general rule in hereditary forms of cataracts. Nettleship and Ogilvie's family consisted of 288 persons (131 males and 115 females, with 42 whose sex was not disclosed). The cataractous branch included 134 persons (71 males and 55 females, with 6 whose sex was not given); 90 (44 males and 40 females, with 6 whose sex was not stated) were examined, of whom 16 were afflicted (2 others who had died prior to the time of examination were apparently affected, too). The transmission of the anomaly was given as continuous in every instance—in 2 cases through two generations, in 1 case through three generations and in 1 case through four generations. Transmission was through the fathers in 4 cases and through the mothers in 3 cases. The 4 affected fathers produced 8 affected children out of 22; the 3 affected mothers, 5 cataractous children out of 12. The descendants of normal members of the family remained free from the defect. There were only 5 instances of cousin marriages in the entire pedigree. The cataract was present only in one branch of the stock. Although in 3 of 4 cousin marriages one of the cousins was a member of the cataractous branch, the cataract appeared only in the offspring of 1 of these matings, and in this single case one of the parents was affected; in the other cousin marriages, in

26. Bursuk, N.: Formes Frustes of Zonular Cataract, Russk. oftal. zhur. **12**: 485, 1930.

which neither parent was affected, the children remained free. These circumstances exclude the possible role of consanguinity as a hereditary factor.

In the family observed by Chance [7] the father transmitted the condition to his third, fourth and fifth sons and to the daughter (the mother and the first and second sons were free). Other members of the family were not examined. The mode of inheritance represents dominance. In another family, under the observation of Nettleship,[5] consisting of 275 persons (110 males and 115 females, with 50 whose sex was unrecorded), 8 had discoid and 24 zonular cataracts. The details of the disease in the members of this family are given on page 59.

Smith [8] published the pedigree of another family afflicted with the same anomaly, but not related to the Coppocks. The cataracts were of the discoid or retronuclear variety, all fairly dense; the very slight and the lamellar type did not occur. The youngest member affected was 3 and the oldest 64 years of age. The family consisted of 113 persons (information was available on 102), and 26 were affected (24 of the 26 affected members and 49 of the 76 unaffected members were actually examined). One person, with 51 descendants, had 26 affected offspring (15 males and 11 females), an incidence of 50.9 per cent. With 1 exception, every affected person with offspring transmitted the anomaly, the exception being an affected man who had only 1 child. There was not a single instance in which unaffected parents produced an affected child. The defect was transmitted as a typical dominant character through three generations. In the first generation, an affected male produced in the second generation 3 affected females and 1 affected male. The first affected female of the second generation had 12 children, with 2 affected boys and 2 affected girls; the second affected female produced 2 normal and 2 affected sons; the third affected female had 8 children, with 2 affected sons and 1 affected daughter; the affected male had 11 children, of whom 5 sons and 2 daughters showed the anomaly. The third generation transmitted the discoid opacity only through the affected members; 1 affected male, with 2 children, had an unaffected son; his brother had 5 children (2 males and 3 females). with 2 daughters and 1 son showing the disorder; 1 of the brothers had 1 unaffected child, and, finally, the affected female had 3 children (1 son and 2 daughters) with 1 affected son and 1 affected daughter.

Harman could observe the defect in five generations, 17 sibships with 63 persons in direct descent; 8 members died at birth or in infancy, and of the remaining 55 persons 19 were afflicted. As in the previous pedigrees, dominance was the mode of transmission: the affected persons

were always born to affected parents; no cataractous child had normal parents. The transmitters were both males and females. Of the 55 persons, only 36 could be examined, and therefore possibly more than the 19 persons were affected, explaining the shortage of 8 of the mendelian requirement. The opacities were small and close to the nuclear region; in cases in which it showed definite lamellar structure the opacity was small in relation to the total size of the lens, sharply defined and without riders. This family seems to furnish additional evidence of the interchangeability of lamellar and discoid cataract within affected families, similar to that in the family observed by Nettleship.

The German literature showed an apparent unawareness of the morphologic description offered by English and American authors; the hereditary factors concerning the anomaly were similarly overlooked, in some cases even up to very recent times. Vogt was at first entirely ignorant of a similar anomaly; later, in the first edition in his "Atlas," he stated that it was probably congenital, and in the second edition, he presented a pedigree of 1 of his cases but again failed to mention the

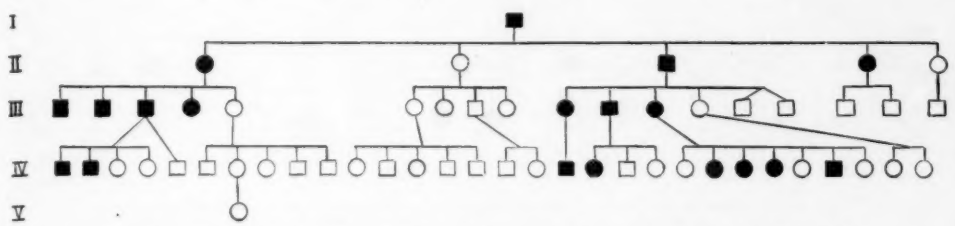

Fig. 3.—Harman's family of 55 members, showing discoid cataract in 19.

hereditary facts available. Prior to the publication of the second edition, however, Gifford's paper appeared in the German language, and Franceschetti [27] discussed Coppock and central pulverulent cataract in the same chapter; later Brückner [28] stated that the two forms are probably identical. The familial appearance was noted in the cases of Poos (mother and 4 daughters affected), Gifford (mother with pulverulent cataract, and son with zonular cataract) and Vogt. Vogt's pedigree shows 5 generations, but actually only 3, members of the first and second generations not having been examined. Scrutiny of this pedigree permits the conclusion of unquestionable dominance of the anomaly if one of the unexamined parents of the second generation was affected. If one were to argue for recessiveness on the supposition that both parents were unaffected but were heterozygous for the anomaly, one must admit the extreme unlikelihood of inheritance of such a rare

27. Franceschetti, A.: Die Vererbung von Augenleiden, in Schieck, F., and Brückner, A.: Kurzes Handbuch der Ophthalmologie, Berlin, Julius Springer, 1931, vol. 1, p. 631.

28. Brückner, A.: Tr. Internat. Ophth. Cong., 1938.

anomaly by this mode unless the parents are closely related; it is known that rare genes do not produce chance combinations in random matings. The familial appearance of this rare disease in children of unrelated parents can be interpreted only as an expression of dominance. Even the possibility that the parents carried the gene in suppressed form and the gene did not come to expression would, similarly, constitute evidence for dominance. In the third generation there were 3 affected and 3 normal children, representing a deviation from the expected 4.5 : 1.5 ratio, and not excluding the possibility of recessiveness. The deviation is of course insignificant; with such small numbers the calculation does not have much meaning, the 3 : 3 ratio not excluding the possibility of recessiveness, even if one were to expect the 3 : 1 ratio—characteristic of recessiveness. Nevertheless, the possibility of recessive inheritance can be discarded on account of the rarity of the gene and the nonconsanguinity of the parents. The family tree shows, in my

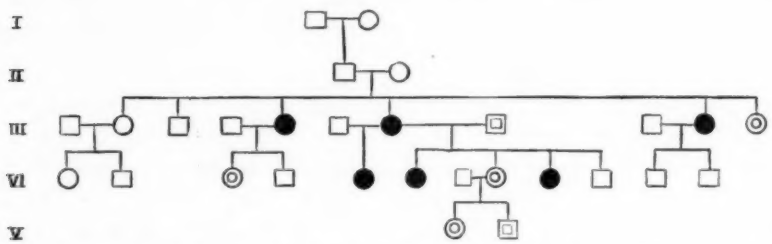

Fig. 4.—Vogt's pedigree, showing heredity of central pulvervulent cataract.

In this figure and in the following figures, the square within a square indicates males examined and not affected, and circles within circles, females examined and not affected.

opinion, one deciding point for dominance, namely, that the 1 affected female of the third generation in mating with 2 males (the first not examined, but supposed to be normal, and the second known to be normal) transmitted the disease to the only descendant of the first union and to 2 out of 4 children of the second union. Considering these facts, the pedigree must be interpreted as expressing dominance, and one must assume that 1 of the unexamined parents of the second generation was so affected.

Moreover, as recessiveness cannot be maintained, the probability that mutation occurred in the third generation does not command any consideration. Whatever the cause of a mutation, whether a change in the quantity of gene, a change from one molecule into quite another, a partial change within the molecule, a change within the tridimensional arrangement of the molecule (formation of stereoisomere) or a quantitative change due to polymerization, one cannot imagine that the alteration of the extremely complicated mechanism within the gene would repeat itself exactly three times out of six within one sibship. But

even if, for argument's sake, one accepts the possibility of mutation in the third generation, the mutant genes, nevertheless, show dominances exclusively.

The mode of inheritance seems to have been definitely settled as dominant in the older literature; only the recent literature, through unawareness of the facts, has seemed to obscure rather than to clarify the problem. Therefore the newer literature has been closely scrutinized and analyzed in the present study. Bücklers [29] dealt with Coppock cataract as a form distinct from the central pulverulent type. He claimed dominant inheritance for the former and cited Nettleship and Ogilvie [1] and Smith [8] each as having described it in 4 generations and Chance [7] and Harman [9] each as having reported it in 2 generations. Central pulverulent cataract, according to Bücklers, was dominant in 2 generations in families reported by Poos and Vogt; and he claimed the possibility of recessiveness for his observation, in which unaffected parents had 4 affected children (2 males and 2 females) in a family of 10 (6 females and 4 males). The observation is in agreement with that of

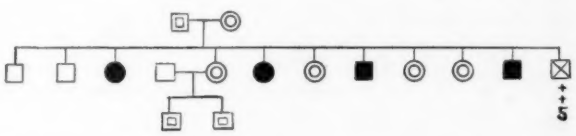

Fig. 5.—Bücklers' family, showing heredity of central pulverulent cataract.

Harman,[30] who described the presence of the cataract in 2 sisters with unaffected parents; Harman did not claim recessiveness in his cases, pointing out only that if traces of the cataract could be found in the relatives of either parent the problem of recessive inheritance would emerge. In order to establish recessive inheritance in Bücklers' pedigree, one must show that both parents were heterozygous in order to produce the anomaly. Considering the rarity of occurrence of this anomaly within the population, the parents should have been close relatives, which was not the case; otherwise mention of it would surely not have been omitted. Recessiveness cannot be excluded, but the incidence is four tenths of the expected, and appearance of the anomaly is very unlikely in random matings of unrelated persons. The probability of dominance cannot be completely discarded; one of the parents may have carried the gene, which did not come to expression.

Analysis shows that in the families reported by Poos and Vogt, respectively, there was unquestionable dominance, and probably also in the case of Bücklers, despite the fact that the latter considered the

29. Bücklers, M.: Erbliche Linsentruebungen, in Gütt, A.: Handbuch der Erbkrankheiten, Leipzig, Georg Thieme, 1938, p. 126.

30. Harman, N. B.: Familial Discoid or Coppock Cataract, Tr. Ophth. Soc. U. Kingdom **30**:29, 1910.

mode of inheritance recessive. The family of Russo [17] is to an even less degree likely to outlive the claim of recessiveness; this case led to a rather confusing presentation of the question by Bellows. His summary of the hereditary influence is regrettably inaccurate and does not clarify the question at all. He made only two citations—the first, that Nettleship and Ogilvie found nearly 20 affected members within one family, but he did not mention the fact that this family was presented as showing a dominant type of heredity, or even refer to all the other proved instances of dominance. The second concerned the family of Russo, and his conclusion that here there was an apparently mendelian recessive inheritance is the only comment concerning the type of inheritance. Certainly, this kind of presentation does not do justice to the known facts of hereditary transmission, not to mention the circumstance that the assertion of Russo does not hold water in the light of present genetic knowledge.

Russo's family started with 2 affected brothers; the first one married a cousin; the second brother's wife was unrelated. The first

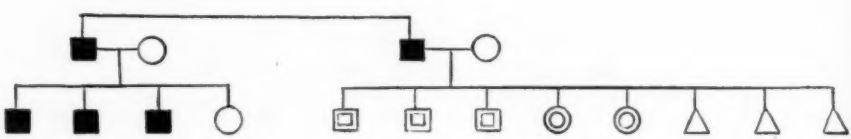

Fig. 6.—Russo's family, showing heredity of central pulverulent cataract. The triangle means that the sex was not stated.

marriage resulted in 3 affected boys and 1 girl, who refused to be examined (9 pregnancies; 4 living children). The second brother had 8 children; 3 males and 2 females were examined and proved to be unaffected; 3 others (sex not given) were not examined. Russo stated that the family of the first brother would support the conclusion of dominant inheritance, but the negative family pedigree of the second brother proved that the mode of inheritance was not dominant but recessive; without the examination of the family of the second brother the recessiveness would have escaped unobserved, as a false dominant trait. The basis of the conclusion is the fact that the disease appeared only in the family of the first brother, therefore only in a consanguineous union, and must be recessive. Bellows not only accepted the opinion of Russo but, by not presenting any facts concerning the proved dominance in other cases, carried the impression of proved recessiveness by implication.

The dominance of the anomaly in the case of the first brother needs no further elucidation. An autosomal dominant gene, if one parent is normal and the other is a heterozygous affected person, would produce 50 per cent normal and 50 per cent heterozygous affected offspring. In the case of the second brother the first, and valid, objection is that only

5 of the 8 children were examined; therefore the possibility that the 3 unexamined children were affected remains undecided. If 1 person in 100,000 is affected, 6 persons in 1,000 would be heterozygous for the defect. AA, Aa and aa would represent the three types of offspring, and necessarily the Aa type would be present in 3 of 100,000 marriages. Therefore the absence of the anomaly in 5 children of the family of the second brother does not exclude the possibility of dominance, for such a ratio could happen by chance once in 32 similar families. If all the 8 children had been examined and been found free of the defect, this would speak against the possibility of dominance, because, on the basis of the same calculation, 8 normal children would happen by chance only once in 256 similar families (chance of A = ½; chance of a = ½; probability in case of 5 unafflicted children $(½)^5 = 1/32$; probability in case of 8 unafflicted children $(½)^8 = 1/256$). Not only is Russo's conclusion of recessiveness, as carried over by Bellows, unproved, but the family tree is most probably an expression of dominant inheritance.

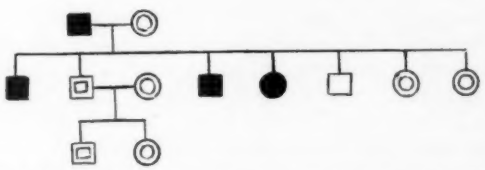

Fig. 7.—Rados's first family, showing central pulverulent cataract.

In the hereditary form of central pulverulent cataract the dominant mode of inheritance is to be expected in accordance with the knowledge of inheritance of various forms of hereditary cataract.

In 2 of the 3 families under my observation the dominant mode of transmission was unquestionable. In the first family, the father had identical small disks, of 2 mm. diameter, consisting of typical small dots within the embryonic nucleus, without a second layer of the dots. He was brown haired and had dark gray irises. The corneal refraction was as follows: right eye: 43.25 and 43.50 D., axis 85; left eye: 43.75 and 44.50 D., axis 105. Vision in the right eye was 15/50, and with a correction of + 0.50 D. sph. ⌒ + 0.75 D. cyl., axis 90 it was 15/20. Vision in the left eye was 15/50, and with a correction of 2.00 D. cyl., axis 105, 15/20. He was 63 at the time of his examination. His wife, aged 58, had reddish blond hair, light blue irises and normal lenses; corneal refraction in each eye measured 43.50 D. Seven children were living (4 boys and 3 girls); 6 were examined; the first and third boys and the first girl were affected like the father. All were unmarried with the exception of the second (unaffected) son, whose 2 children were free of the anomaly. The father was the transmitter of the cataract to the second generation, and the affected members not only exhibited a cataract similar to that of the father but showed astigmatism of varying degrees. The oldest boy in the second generation had the same small central opaque disk in both lenses; he had brown hair and blue irises; the corneal refraction measured 40.00 and 41.75 D. in the right eye and 41.25 and 41.50 D. in the left eye. Vision in the right eye was 15/100, and with a correction of + 1.75 D. cyl., axis 90,

15/20 in the left eye vision was 15/100, and with a correction of 1.50 D. cyl., axis 90, 15/20. The second (unaffected) son was blond with gray irises; corneal refraction in each eye measured 44.25 D.; vision was 15/20 in each eye, and 15/15 with a correction of + 0.75 D. The third (second affected) son, again, had brown hair and blue irises; the opaque disks in his case had a diameter of approximately 4 mm., filling out the undilated pupil entirely. The morphologic character of the larger disks in his cases was the same as that in the previous cases—minute gray dots surrounded by a lighter halo, without the presence of larger dots or a second ring of dots. Corneal refraction measured 43.25 D. in the right eye and 43.25 and 43.50 D. in the left eye; vision in the right eye was 15/100, and 15/20 with a correction of + 1.75 D. sph. ⌒ + 0.75 D. cyl., axis 90; vision in the left

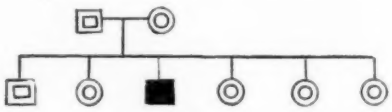

Fig. 8.—Rados's second family, with central pulverulent cataract.

eye was 15/200, and 15/30 with a correction of + 2.75 D. sph. ⌒ + 0.50 D. cyl., axis 90. In the case of the first daughter the opacity measured 3.5 mm. and was round, with cleancut edges (larger than in the cases of the father and the first affected son and smaller than in the case of the second affected son); she had blond hair and light blue irises; her corneal refraction was 43.50 and 44.75 D. in the right eye and 43.00 and 44.50 D. in the left eye; vision was 8/200, and with a correction of — 6.50 D. sph. ⌒ — 1.0 D. cyl., axis 180 it was 15/20; vision in the left eye was 8/200, and with a correction of — 5.00D. sph. ⌒ — 1.25 D. cyl. axis 180, 15/20. The next in line, a son, could not be examined but allegedly had normal eyes. The fifth and sixth children, both unaffected girls, had blond hair

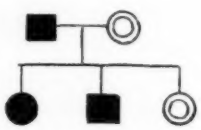

Fig. 9.—Rados's third family, with central pulverulent cataract.

and light blue irises. The fifth child had a corneal refraction of 42.50 D. and visual acuity of 15/30 (15/15 with a correction of + 0.75 D. in each eye); the sixth child had corneal refraction of 44.75 D. in the right eye and 44.25 D. in the left eye, and a visual acuity of 15/30 (15/15 with a correction of + 0.50 D.). All the refractive data were obtained in the first generation with eucatropine and in the second generation with homatropine. The children of the third generation (1 child, 3 years of age) had normal lenses; refractive data could not be obtained because of lack of cooperation. In the second generation the children inherited the cataract together with the corneal astigmatism from the father; the children with clear lenses were free from astigmatism, a defect known to follow the rule of dominance.

In a second family, the father and mother and 6 children (2 boys and 4 girls) were examined, and only 1 child, the second son, was typically affected, the opacity measuring about 2 mm. and occupying the embryonic nucleus, without an additional line of dots. The second child, a girl, had normal lenses but showed heterochromia

of the irises, the right iris being brown and the left light blue, with a few white corneal deposits in the lighter-colored eye.

In the third family, the father had a small central opaque disk in the embryonic nucleus in each eye; in front of the nucleus toward the posterior layers of the anterior cortex, lay a thick, gray, massive opacity, with diffuse, delicate, stripe-shaped opacities in the anterior and, especially, in the posterior cortex. There were a few angular opacities in each lens. The mother and the youngest girl had clear lenses. The oldest child, a girl, and the second child, a boy, had a similar condition in both eyes; in the case of the girl the associated opacities of the posterior cortex were denser; in the case of the boy, in front of the small central pulverulent cataract, there was a dense pyramidal projection toward the anterior cortex.

In the first and third families the trait showed abundant evidence of a dominant mode of inheritance. In the second family, in which a single case was observed in the family, the possibility of mutation, as in all isolated cases, must be considered; the rarity of the gene and the nonconsanguinity of the parents do not permit the conclusion of recessiveness. Rare genes have a small incidence in the population, and the disease assumes an overt form only when the genes conveying the trait are inherited from both parents (heterozygous normal persons). When the character is rare, the chances of this happening are negligibly small; except in cases of consanguinity there is the possibility that two such rare genes are brought together by chance.

The family trees reported in this paper and the literature show that the mode of inheritance is dominant. As I have proved, the recessive inheritance claimed by a few authors cannot be substantiated. The evidence for the dominant mode of inheritance is apparently unanimous in the case of central pulverulent cataract, which is not always the case, as it is known that some anomalies may behave as a dominant in one family and as a recessive in another. Two possible solutions may be offered in explanation of this behavior. First, identical phenotypic diseases are not necessarily identical genotypic deviations. Second, a certain anomaly is dependent on the cooperation of multiple genes, which may be so closely attached to one another in the chromosome that they usually act as a unit but may become separated; a given person might possess only the incomplete set of genes, which would require union with the complementary genes in order to produce the typical anomaly. Therefore the disease might behave as a dominant in one family, before the separation of the genes, and as a recessive in the same family, after the separation took place. The splitting or dissociation of the genes explains the rare cases in which the mode of inheritance of a certain anomaly changes the mode of inheritance within the same family in the course of the successive generations. Central pulverulent cataract does not show such changes of transmission; the so-called recessive inheritance was only suggested, but not proved.

31 Lincoln Park.

EFFECT OF GRENZ RAYS ON LEPROUS INFILTRATIONS

III. Response of Lesions of the Anterior Portions of the Eyeball

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INVOLVEMENT of the eye is one of the most serious complications of leprosy. Opinions differ as to the frequency of occurrence of such involvement. Rogers and Muir [1] found involvement of the eye in 5 to 10 per cent of their patients with lepromatous leprosy. De Silva,[2] as well as Neve,[3] stated that the percentage for this complication was 20 to 25. Chance,[4] in Norway, found ocular involvement in 90 per cent of patients who had lepromatous leprosy and in 75 per cent of patients who had the neural type of leprosy. Borthen [5] reported involvement of the eye in 91.92 per cent of women who had the tuberculous and neural types of leprosy and in 98.33 per cent of men who had these forms of leprosy. Duke-Elder,[6] citing data given by various authors, pointed out that ocular involvement is likely to occur at any time during the course of leprosy.

GENERAL CONSIDERATIONS

It would appear that in regions in which the body is usually covered with clothes, the face and, consequently, the eyes are involved more frequently than is true in countries in which such covering is not the

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1. Rogers, L., and Muir, E.: Leprosy, ed. 2, Bristol, John Wright & Sons, Ltd., 1940.

2. de Silva, W. H.: Lepra Ophthalmica in Ceylon, Ophthalmoscope **6**:70-76 (Feb.) 1908.

3. Neve, A.: Notes on Ocular Leprosy, Brit. M. J. **1**:1153 (May 12) 1900.

4. Chance, B.: The Ocular Aspect of Leprosy, Ann. Ophth. **25**:432-433 (April) 1916.

5. Borthen, L.: Die Lepra des Auges: Klinische Studien, mit pathologisch-anatomischen Untersuchungen von Dr. H. P. Lie, Leipzig, Wilhelm Engelmann, 1899.

6. Duke-Elder, W. S.: Text-Book of Ophthalmology, St. Louis, C. V. Mosby Company, 1938, vol. 2, pp. 1480-1481.

rule. Soto[7] classified ocular complications of leprosy under three categories, according to the mode of formation: (1) extensions of leprous processes situated elsewhere; (2) endogenous foci, carried by way of the blood stream, and (3) extensions proceeding along the nerve trunks.

The ocular lesions most commonly encountered in the aforementioned regions consist of lepromas, which as a rule appear temporally on the bulbar conjunctiva close to the limbus as yellowish, gelatinous nodules; from there they tend to invade the cornea. There is a certain superficial resemblance between these nodules and the limbal forms of spring catarrh (vernal conjunctivitis). These infiltrations, as they progress into the deeper layers of the cornea, produce severe visual disturbances. As a rule, the nodules do not remain confined to the bulbar conjunctiva; they are likely to spread from this site to the sclera.

It is this type of ocular lesion in particular that is somewhat amenable to local therapy unless the process has penetrated too far into the eye or—as often happens—the process originates from the ciliary body. The usual treatment of lepromas of the anterior portions of the eyeball consists of the application of solid carbon dioxide, the local injection of various drugs and surgical measures. It might, therefore, be expected that a suitable form of radiant energy might also prove helpful.

PREVIOUS THERAPEUTIC INVESTIGATIONS

In previous experiments with irradiation, it was found that cutaneous lepromas were noticeably affected by the grenz rays.[8] In the case of such irradiation of facies leontina and lepromas of the skin of the hands, the results also were fairly good, and local recurrences could be forestalled by adequate doses of the rays.[9]

Before the rays were applied to the eyeball, it was important to know whether grenz rays would be absorbed by the superficial layers of the anterior parts of the eyeball, and, if so, to what degree. It was also important to know whether there was any likelihood of damage

7. Soto, M. C.: Algunas consideraciones sobre el tratamiento de las complicaciones oculares de la lepra, Rev. argent. dermatosif. **27**:429-433 (Sept.) 1943; Consideraciones clínicas sobre las complicaciones oculares de la lepra, ibid. **27**:412-422 (Sept.) 1943.

8. Sagher, F.: Effect of Grenz Rays on Leprous Infiltrations: Report of an Attempt to Influence Leprous Infiltrations by Roentgen Rays of Long Wavelength, Arch. Dermat. & Syph. **50**:311-314 (Nov.) 1944.

9. Sagher, F., and Franco, S.: The Effect of Grenz Rays on Leprous Infiltration. II. Report of an Attempt to Influence Facies Leontina and Perforating Ulcer of the Foot by Roentgen Rays of Long Wavelength, Dermatologica **93**:272-294, 1946.

to the lens and deeper structures. In earlier experiments on rabbits and on excised human eyes, it was ascertained that between 89 and 97 per cent of grenz rays were absorbed by the human cornea and that between 88 and 94 per cent of the rays were absorbed by the sclera.[10] On exposure of the cornea and aqueous humor to these rays, absorption was between 97 and 99 per cent, so that practically the question of damage to the deeper structures did not arise.

Furthermore, it had to be decided beforehand whether or not large doses, such as are necessary for the treatment of lepromas, would damage the eyeball. Experience in this regard is not extensive. Pfeiffer[11] reported on 4 patients who had received four series of five treatments, each treatment consisting of 452 r, in a total of five sittings, with rest intervals of two weeks. He described "remarkable reactions of the conjunctiva and the episcleritic tissue." Krasso,[12] experimenting on animals, reported that ocular damage occurred only after 7,830 r had been administered; the reaction, although gradually subsiding, was still ascertainable histologically in the cornea when the eye was excised after two hundred and twenty-four days. Bucky[13] recommended a dose of from 1,500 to 2,500 r for the treatment of superficial tumors of the eye.

On the basis of experience gained in irradiation of lepromas of the skin, it follows that doses of less than 400 r have no considerable effect, and that to achieve satisfactory results the individual doses should be between 600 and 1,000 r. In some cases, however, administration of doses within this range was followed by erythema and scaling, and it was questionable whether the eye would tolerate this kind of treatment. In the first 3 patients in our series, therefore, it was chiefly the tolerance and the reactions of the cornea and conjunctiva to such doses that had to be studied.

In the first patient, a lepromatous eye, practically blind from early childhood, was irradiated. In the second patient, a completely blind lepromatous eye was irradiated. In the third patient, an eye was treated the cornea of which was completely covered with a lepromatous pannus. Only after these experiments had proved innocuous, and even encouraging, were additional patients treated. These additional

10. Sagher, F., and Sagher, E.: Absorption of Infra-Roentgen (Bucky) Rays of Various Qualities by the Anterior Portions of the Eyeball, Arch. Ophth. **30**:43-53 (July) 1943.

11. Pfeiffer, R. L.: Treatment of Diseases of the Eye with Grenz Rays, Arch. Ophth. **21**:976-986 (June) 1939.

12. Krasso, I.: Experimentelles und histologisches über den Einfluss einer einmaligen Bestrahlung mit Bucky's Grenzstrahlen auf das gesunde Kaninchenauge, Ztschr. f. Augenh. **70**:237-256 (Feb.) 1930.

13. Bucky, G.: Grenz Ray Therapy, New York, The Macmillan Company, 1929.

patients were 3 persons whose vision was fairly good or good; they, similarly, received irradiation therapy.

TREATMENT

The eyes were anesthetized by the instillation of a 4 per cent solution of cocaine hydrochloride; the eyelids were opened as wide as possible with Desmarres' retractors. The patient was then asked to glance in such a way that the leproma appeared in the middle of the palpebral fissure. The irradiation tube was adjusted vertical to the leproma at a distance of 10 cm. Tears, likely to absorb a considerable portion of the rays, were swabbed away with cotton wool. The lid retractors were placed in such a way as to cover the eyelids with their broad portions, since otherwise considerable erythema of the skin of the eyelids might result. A bismuth paste was applied to those portions of the skin which remained uncovered.

REPORT OF CASES

CASE 1.—A woman aged 39 presented lepromatous leprosy with all its clinical and bacteriologic characteristics. Since the end of 1941 she had had a limbal leproma in her left eye. Treatment with solid carbon dioxide, which she had previously received several times, had had no appreciable effect. For the three months prior to the time we saw her the patient had remained without treatment. Examination on March 16, 1941 disclosed no specific changes in the eyes. The left eye presented corneal opacities, which had been there since the patient's earliest childhood. The fundus was normal. The only symptom was a certain immobility of the pupils; they did not dilate after the application of homatropine. On Dec. 8, 1941, the patient returned because of superficial opacity of the entire left cornea and a leproma on the temporal side, occupying a third of the cornea and probably penetrating through all its layers. There was occlusion of the pupil as a sequel of cyclitis. The patient could count her fingers only at a distance of 59 inches (1.5 meters). She complained of attacks of severe pain in her eyes. Nothing abnormal was noted in the right eye.

On December 8, 1941, 1,200 r was administered to the left eye. The factors were: 170 volts; 10 milliamperes; approximately 6 kilovolts, which is equivalent to a half value layer of 0.021 mm. of aluminum; distance, about 4 inches (10 cm.); rate of exposure, 375 r per minute. On Jan. 15, 1942, 1,200 r was administered. No changes were noticeable thereafter, although the patient reported that the pain had subsided. On February 5, 1,200 r was administered. Occasionally slight irritation of the eye was noted. On March 10, 2,000 r was administered. Intense conjunctival injection was seen. The patient had been free from pain all the time. On April 23, 1,200 r was administered. On June 1, it was seen that the leproma had become definitely flatter. Dilated blood vessels were now seen surrounding the lesion. On July 7, 1,200 r was given; on August 4 this dose was repeated, followed by the same dose on September 3. The total dose was 11,600 r.

On Nov. 15, 1942, biopsy of a specimen of tissue from the site of the leproma showed, beneath the mucous membrane, small lesions containing acid-fast bacilli, partly isolated, partly in groups.

The patient was kept under constant observation. When she was last examined, on Oct. 2, 1945, the left eye presented a grayish white, completely flat opacity at the former site of the leproma, with small, degenerative inclusions. Behind the radially arranged deposits, streaks were seen which resembled folds of the lamina elastica posterior. The anterior chamber was deep; there was partial atrophy of the iris. The pupil was occluded by a dense membrane.

The patient was able to count her fingers at about 20 inches (0.5 meter). In the right eye a slight, whitish protuberance with enlarged blood vessels was present at the limbus; it extended from 9 to 2 o'clock. Toward the cornea the borderline of this protuberance was indistinct. On the temporal side, the cornea contained a slight, subepithelial opacity; the iris showed small, yellow nodules (nodular iritis). The lens was normal.

CASE 2.—A girl aged 19 had had lepromatous leprosy for four years prior to the time of her admission. Examination of the eyes disclosed not too dense superficial keratitis in the right eye, with a moderate number of keratic precipitates. The upper and nasal part of the iris showed a large leproma; temporally, small white nodules were seen. Occlusion of the pupil was noted. The patient could distinguish hand movements. The fundus was invisible.

Right eye of the patient in case 2, after irradiation, as compared with the left eye, which was not treated. The left eye is distinctly inflamed. The cornea of the left eye is more opaque than the cornea of the right eye.

Dense keratitis, with abundant keratic precipitates, was present in the left eye. A few isolated nodules were apparent in the iris. Posterior synechia, not clearly visible because of corneal opacity, was detected. The patient could count fingers at about 10 feet (3 meters). She complained of severe pain and of lacrimation.

Between Jan. 15 and Aug. 4, 1942 the patient received irradiation of the right eye with doses of between 1,200 and 1,500 r, to a total of 7,800 r. The factors were: 210 volts; 5 milliamperes; 14 kilovolts, filtered through 0.01 mm. of cellophane, which is equivalent to a half value layer of 0.031 mm. of aluminum; distance, 10 cm.; rate of exposure, 462 r per minute. Treatments were given at intervals of four to six weeks.

After the patient's second sitting the pain subsided. Occasionally there was a slight erythematous reaction. After the course of treatment had been completed, there was no evidence of irritation, whereas the untreated eye was distinctly inflamed (figure). The left cornea at this time was definitely more nearly opaque than the right one.

The patient was under observation until Jan. 18, 1944. The condition of the affected eye remained stationary.

Examination on Jan. 18, 1944 showed that the right eye was not irritated. In the center of the cornea a superficial opacity was seen; in the periphery grayish dots and deep blood vessels were evident. The iris showed no changes in the condition seen at previous examinations. Occlusion of the pupil was noted. There was no perception of light. The left eye, similarly, was not irritated, but there was opacity of the cornea, with deep and superficial blood vessels. No details of the iris were discernible because of the dense opacity. There was no perception of light.

The patient died in October 1945, from complications of the rapidly progressing leprosy.

CASE 3.—A woman aged 27 had had lepromatous leprosy for nine years prior to the time we saw her. At examination on Feb. 22, 1944 (prior to irradiation therapy) a leukoma was seen to occupy half the cornea. The rest of the cornea was opaque. On the lower portion of the limbus a small leproma was surrounded by dilated blood vessels. On examination with the slit lamp the nasal side of the cornea seemed to be slightly clearer; otherwise, deep blood vessels were visible in the whole area. The patient could count fingers near the eye. The fundus was not visible. Examination of the right eye with the slit lamp showed that the entire cornea was opaque, with superficial and deep blood vessels evident to a somewhat less degree on the nasal side. The nerve fibers were thickened. The iris, lens and fundus were normal. Vision was 5/9.

Irradiation of the left eye was started on Feb. 23, 1944. The factors were: 210 volts; 10 milliamperes; 10 kilovolts, which is equivalent to a half value layer of 0.027 mm. of aluminum; distance, 10 cm.; rate of exposure, 660 r per minute. On March 21, 1944, 800 r was administered. The leproma on the lower portion of the limbus presented a central depression, which stained with fluorescein. There was no irritation. On May 10, 1944, 700 r was administered. The leproma was flatter and did not stain with fluorescein. Between May 30 and Oct. 23, 1944, five more irradiations, with doses of 600 to 800 r each, were carried out. The total dose administered (February to October) amounted to 5,500 r.

From time to time the patient reported for examination; at the last time, on May 1, 1946, she was found to be in a very poor general condition because of the rapid progression of the lepromatous process all over her body.

A total leukoma was seen in the left eye; and a new leproma surrounding the cornea had appeared, leaving the area which had been exposed to treatment with the grenz rays definitely flatter.

A large leproma was spreading over the cornea of the right eye, only the upper nasal portion being still intact.

CASE 4.—A woman aged 25 had had lepromatous leprosy, with extensive bilateral involvement of the ulnar nerve, for twelve years prior to the time we saw her. Examination of the left eye (prior to irradiation treatment) revealed a leproma on the temporal part of the limbus, extending over approximately one-half the cornea. That part of the cornea which lay outside the leproma was clear. The leproma was elevated above the plane of the cornea by approximately 3 to 5 mm. The patient could count fingers at about 11 feet (3.5 meters). Cyclitis, with yellow patches in the iris, was present. Examination of the fundus disclosed anterior choroiditis. There were no changes in the right eye; vision was 5/11.

In the period between Oct. 28, 1943 and July 24, 1944 the patient received a total of 8,000 r, in doses of 800 r each, at intervals of four to six weeks. The irradiation factors were the same as those employed in case 3.

Before irradiation was started, a specimen for biopsy was taken from the area occupied by the leproma. Histologically, no granulation tissue was observed, because the section was too superficial, consisting almost exclusively of epithelium of the mucous membrane. Mycobacterium leprae was not demonstrated.

Half a year after treatment had been started the leproma began to be definitely flatter, that is, after a total of about 4,800 r had been administered.

The patient was under observation all the time. At the last examination, on May 1, 1946, the left eye was seen to contain, instead of the leproma, a leukoma, with dilated blood vessels. Outside the area of the leukoma the cornea had a normal appearance. The iris was not irritated. The lens was normal. The patient could count fingers at about 6 feet (1.5 meters).

The right eye contained a slight corneal opacity; central choroiditis was evident.

Case 5.—A girl aged 18 had had lepromatous leprosy for six years prior to her coming to consult us. She complained of pain in both eyes.

Examination of the right eye (prior to irradiation treatment) revealed infiltration of the bulbar conjunctiva at a distance of approximately 2 mm. from the upper part of the limbus. Deep opacity of the cornea extended tonguelike, from above downward, almost to the center of the cornea. From all sides superficial vessels were seen proceeding toward the cornea, leaving only the center intact. The iris, lens and fundus were normal. Vision was 5/15.

Infiltration of the bulbar conjunctiva of the left eye extended from 11 to 5 o'clock, with pronounced inflammation. In the upper sector of the cornea a leproma was observed extending tonguelike down to the center. The iris, lens and fundus were normal. Vision was 5/30.

In the period from April 18 to Nov. 30, 1944, the leproma of the left eye was irradiated, the patient receiving a total of 7,400 r, in doses of 800 to 1,000 r each. The factors were the same as those used in case 3. In spite of the irradiation, the leproma continued to grow, while, at the same time, numerous fresh nodules and infiltrations developed all over the body, including the face.

The patient was under observation during the entire period of treatment. At the last examination, on May 1, 1946, a leproma, approximately 4 mm. in height, was observed on the lower portion of the limbus (from 10 to 4 o'clock) in the left eye, with infiltration of the entire cornea, leaving a slightly clearer area in the center. At the site at which the leproma had been only ciliary injection could be noticed.

The right eye exhibited a ring-shaped leproma at the limbus; in the upper portion of the cornea was a deep, gray opacity.

Case 6.—A woman aged 33 had had lepromatous leprosy for five years prior to the time we saw her. She complained of constant pain in her eyes.

Examination of the right eye (prior to irradiation treatment) disclosed a leproma of the conjunctiva on the temporal portion of the limbus, encroaching 2 mm. on the cornea. The superficial corneal layer was transparent; the deeper layers were infiltrated with deep blood vessels. The leproma was elevated above the plane of the cornea by approximately 2 mm. In the left eye the same conditions were seen as those in the right eye, except that the leproma was slightly smaller,

encroaching on the cornea only 1 mm. and elevated approximately 1 mm. Vision in both eyes was 5/7. The pupils were not exactly round; but the iris, lens and fundus did not present anything abnormal.

Grenz ray therapy was confined to the leproma of the right eye, which had the more extensive involvement. In the period from Feb. 23, 1944 to Jan. 1, 1945, a total of 9,100 r was administered, the patient receiving doses of 700 to 1,000 r at a time. The factors were the same as those utilized in case 3.

After the administration of a total of 4,300 r, the leproma became definitely flatter. The patient was under observation during the entire period of treatment. At the last examination, on May 1, 1946, the right eye was seen to contain a leproma on the temporal side of the cornea; this leproma had become flattened but was still slightly brownish opaque. In the lower sector were a few isolated blood vessels; at one place a large blood vessel was seen to penetrate into the conjunctiva, which appeared to be normal. The opaque area of the cornea was approximately 1.5 cm. in diameter. The left eye, which had not been irradiated, exhibited between 5 and 9 o'clock a broad prominence, about 3 or 3.5 mm. wide, overhanging the limbus so as to form a furrow. The adjacent portion of the cornea contained a band-shaped, white opacity, between 1 and 1.5 mm. wide. Pain was also more intense in the left eye than in the right eye. The lens was normal. Vision was 5/8.

Comment.—In principle, only one eye of a patient was irradiated, usually the more severely affected one, the other eye serving as a control. The patient in case 1 had a leproma in the left eye, which eye had been amblyopic from childhood as a result of corneal scars. Damage that might be caused by irradiation could not, therefore, have been of any consequence. Doses of 1,200 r elicited no reaction except for an occasional slight irritation, which persisted for one day to two days. After exposure to still larger doses, however, all patients reported intense irritation, with a sensation of burning and occasional slight photophobia. Tolerance was satisfactory if doses did not exceed 1,200 r and were administered at intervals of four to six weeks. In case 1 the leproma disappeared completely, leaving a scar. During a follow-up period of four years no recurrence was noted at this site, and no changes were observed in the inner structures of the eye. The untreated eye, on the other hand, showed rapid progression of the leprous process concomitant with the advance of the cutaneous lesions all over the body. For the patient herself, it was particularly important that pain had been relieved during the entire period of treatment, whereas previously she had had frequent attacks of violent pain.

In case 2 the patient had been selected for the purpose only of ascertaining the tolerance of the eyeball to very large doses, since it was recognized that she had superficial keratitis, with occlusion of the pupil. That is, the eye was already blind, so that there could be no question of damage to vision with the procedure. The tolerance was satisfactory when doses of 1,200 r were employed, whereas violent reactions were elicited with doses of 1,500 r. In this case, too, the

analgesic effect was an outstanding feature, an aspect that Pfeiffer [11] emphasized in his therapeutic investigations. Although pain disappeared completely from the treated eye, it persisted with undiminished severity in the untreated one. Some degree of improvement in the keratitic process was even noted, the cornea becoming slightly clearer and inflammation subsiding—an effect that is clearly noticeable in the figure.

The patient in case 3 presented severe superficial, as well as deep, opacities of the cornea, with a leproma of the limbus and an ulcer in the lower sector. After irradiation the leproma became flatter, whereas the cornea itself was unchanged.

The patient in case 4 had a leproma at the temporal edge of the cornea of the left eye; this leproma extended as far as the pupil, thus seriously interfering with vision, so that the patient was able to count fingers no closer than about 11 feet (3.5 meters). After she had received a total of 8,000 r, the leproma completely disappeared, leaving a white scar. During the entire follow-up period, extending over two and a half years, no corneal or lenticular changes were noted, and the leproma did not recur. Vision remained unchanged, for all practical purposes. During this period, however, the originally unaffected right eye became involved.

In case 5, lepromas were present not only in the eyes but all over the body, and the number was rapidly increasing. The patient's condition was deteriorating rapidly. In this case, irradiation seemed to exert an adverse effect. At the site of irradiation no noticeable changes occurred, whereas in the neighboring parts of the eyeball new lepromas appeared and developed rapidly.

The patient in case 6 eventually presented slowly growing lepromas in both eyes. These lesions uniformly advanced over the limbus, the lesion in the right eye being slightly larger than that in the left eye. Vision was 5/7 in each eye. Irradiation was, therefore, confined to the right eye, in which the leproma was larger than the leproma in the left eye; at the end of the treatment it was definitely less elevated. During the same period new lesions developed all over the patient's body. Since, however, the leproma in the untreated eye was developing only slowly, irradiation was not continued up to a maximal total dose. During a period of two and a quarter years, vision, as well as the inner structures of the eye, remained unaffected.

QUALITY AND DOSAGE OF THE RAYS

Various grades of "hardness" of the rays were employed. In case 1 grenz rays of long wavelength ("soft rays") were applied; that is, the voltage was 6 kilovolts, which is equivalent to a half value layer of 0.021 mm. of aluminum. It was established that when the rays were used the cornea absorbed 95 per cent of them; the cornea and the

aqueous humor together probably absorb 100 per cent of them, so that the danger of damage to the lens is practically nonexistent. In the second case, the rays of short wavelength ("hard rays") were purposely chosen; that is, the voltage was 14 kilovolts, which is equivalent to a half value layer of 0.031 mm. of aluminum. This was achieved by the insertion of a cellophane filter corresponding to 0.01 mm. of aluminum.

In the remaining cases the rays used were of medium quality; that is, voltage was 10 kilovolts, equivalent to a half value layer of 0.027 mm. of aluminum. When doses up to 10,000 r were used, the quantities of rays penetrating the cornea or sclera and the aqueous humor were insufficient to cause damage to the lens or deeper structures of the eye. This could be confirmed in our series, so far as the condition of the cornea permitted us to examine the interior of the eye. The periods of observation, starting from the first irradiation, extended up to four years.

For purposes of comparison, in 1 case an area of skin 2 by 2 cm. in diameter was exposed to 800 r of the same type of rays as those to which the eye was simultaneously exposed. Although on the next day the eye showed only slight redness and during the subsequent weeks no reaction at all, waves of erythema developed on the skin to such a degree that even after four weeks scaling was still in progress, and as late as eight months later delicate pigmentation was still noticeable.

From this investigation it clearly follows that the reaction of the eye to exposure to grenz rays is far less intense than that of the skin. Since the erythematous reaction of the skin is of a vascular nature, it is understandable that the cornea cannot possibly show this sort of response.

Although the studies reported in the foregoing portion of the text prove that lepromas of the anterior portions of the eyeball cannot be affected by grenz rays, no definite therapeutic conclusions can be drawn, in view of the small number of observations.

SUMMARY

Grenz rays were applied to lepromatous changes in the anterior segments of the eyeball in 6 patients. Since it was obvious, on the basis of experience with irradiation of the skin, that only large doses would be able to produce an effect, 3 practically sightless eyes were chosen for exposure to these rays. In all 3 patients the lepromas undoubtedly became reduced in size or disappeared completely.

When the grenz rays were employed on the eyes of 3 additional patients which presented lepromas with fairly good vision, 2 eyes

exhibited a favorable response, whereas in the third the lepromatous part which was irradiated became quiescent, or even slightly flatter, while the surrounding parts presented rapid growth of new lepromas.

The voltage of the rays used ranged from 6 to 14 kilovolts, which is equivalent to half value layers of 0.021 to 0.031 mm. of aluminum. The most effective doses applied at one sitting were from 700 to 1,200 r, the total amount varying from 5,500 to 11,600 r.

These large doses could be applied safely to the external tissues of the eye because the sensitivity of such tissues to rays is lower than that of the skin.

No damage to the cornea, lens or deeper structures of the eye was noted, so far as this could be determined on the basis of observations extending over a period of between two and four years.

Dr. H. J. Stern, assistant in the Department of Ophthalmology of the Rothschild-Hadassah University Hospital, took an active part in these studies before joining the army. Dr. J. Landau, assistant in the same department, aided in the study.

PATHOLOGIC STUDY OF OCULAR LESIONS DUE TO LEWISITE (β-CHLOROVINYLDICHLOROARSINE)

Changes With and Without BAL (2,3-Dimercaptopropanol) Therapy

FRANCIS HEED ADLER, M.D.

WILFRED E. FRY, M.D.

AND

IRVING H. LEOPOLD, M.D.

PHILADELPHIA

IN STUDYING the pathologic changes produced by various war gases, it became apparent that certain histologic events were common to all. All eyes exposed to severe burns with mustard gas (2-chloroethyl sulfide),[1] lewisite (β-chlorovinyldichloroarsine)[2] and nitrogen mustards (β-chloroethylamine)[3] showed the following alterations:

1. Epithelial changes, followed by loss of epithelium
2. Endothelial changes, followed by loss of endothelium
3. Alteration of stromal cells, leading to death of the cell, disappearance of stromal nuclei and, eventually, some loss of stromal substance
4. Edema of the corneal stroma
5. Cellular infiltration of the cornea first with polymorphonuclear leukocytes and later with lymphocytes and large mononuclear cells
6. Vascularization of the cornea

From the Department of Ophthalmology of the University of Pennsylvania Hospital.

The work described in this paper was done under a contract recommended by the Committee on Medical Research, between the office of Scientific Research and Development and the University of Pennsylvania.

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2. (*a*) Hughes, W.: Clinical and Pathologic Course of Mustard Gas Burns of the Rabbit's Eye, personal communication to the authors. (*b*) Adler, F. H.; Fry, W. E.; Leopold, I. H.; LaMotte, W. O., Jr., and Frisch, F.: Pathologic Course of Lewisite Lesions of the Rabbit's Eye, personal communication to the authors.

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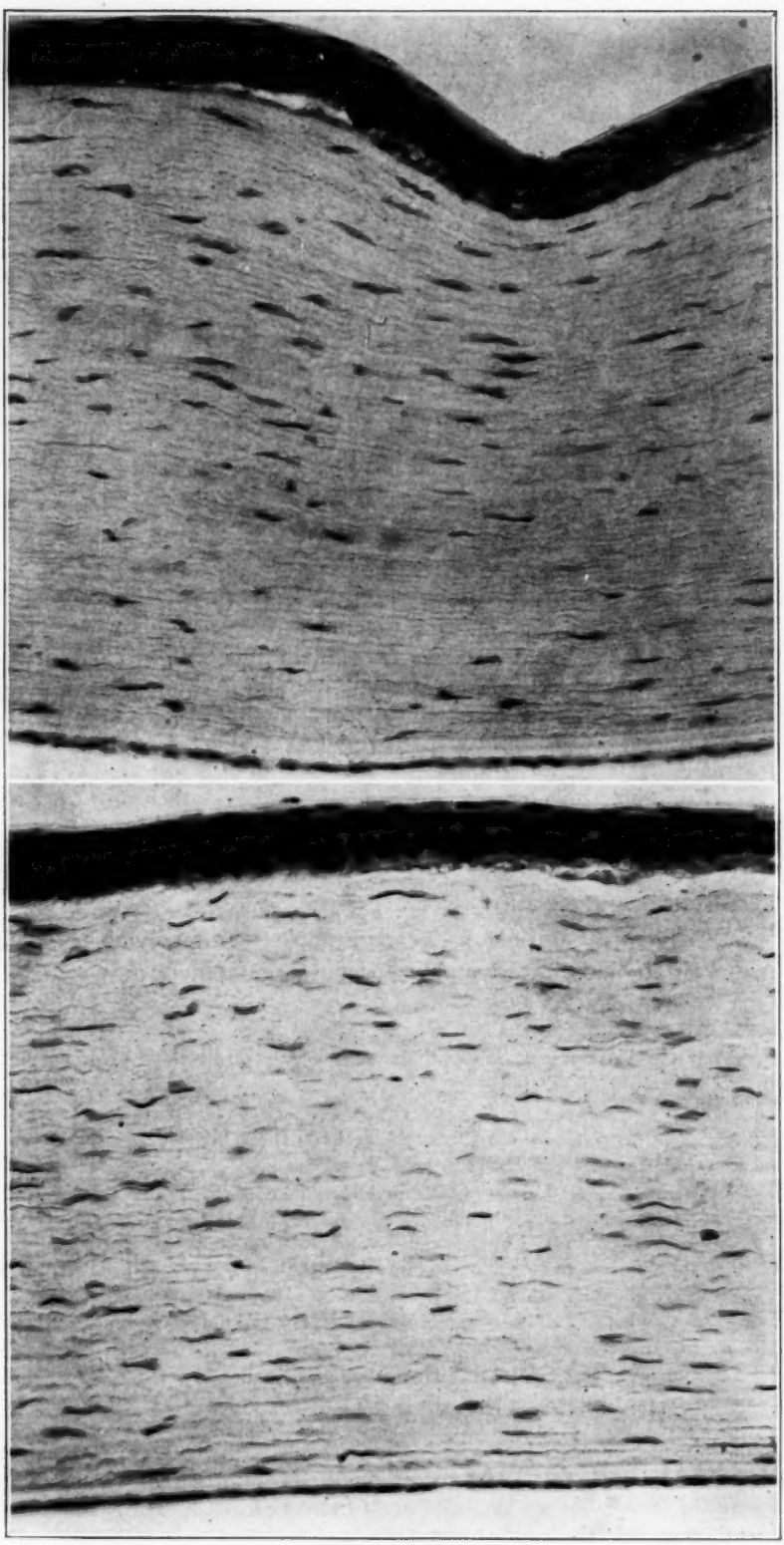

Fig. 1.—Corneas of untreated (above) and treated eyes one hour after burning with 0.4 mg. of lewisite (β-chlorovinyldichloroarsine). The treated eye received a 5 per cent solution of BAL (2,3-dimercaptopropanol) two minutes after burning. Hematoxylin-eosin stain; magnification. 330.

Fig. 2.—Irises of untreated (above) and treated eyes one hour after burning with 0.4 mg. of lewisite. Hematoxylin-eosin stain; magnification, 330.

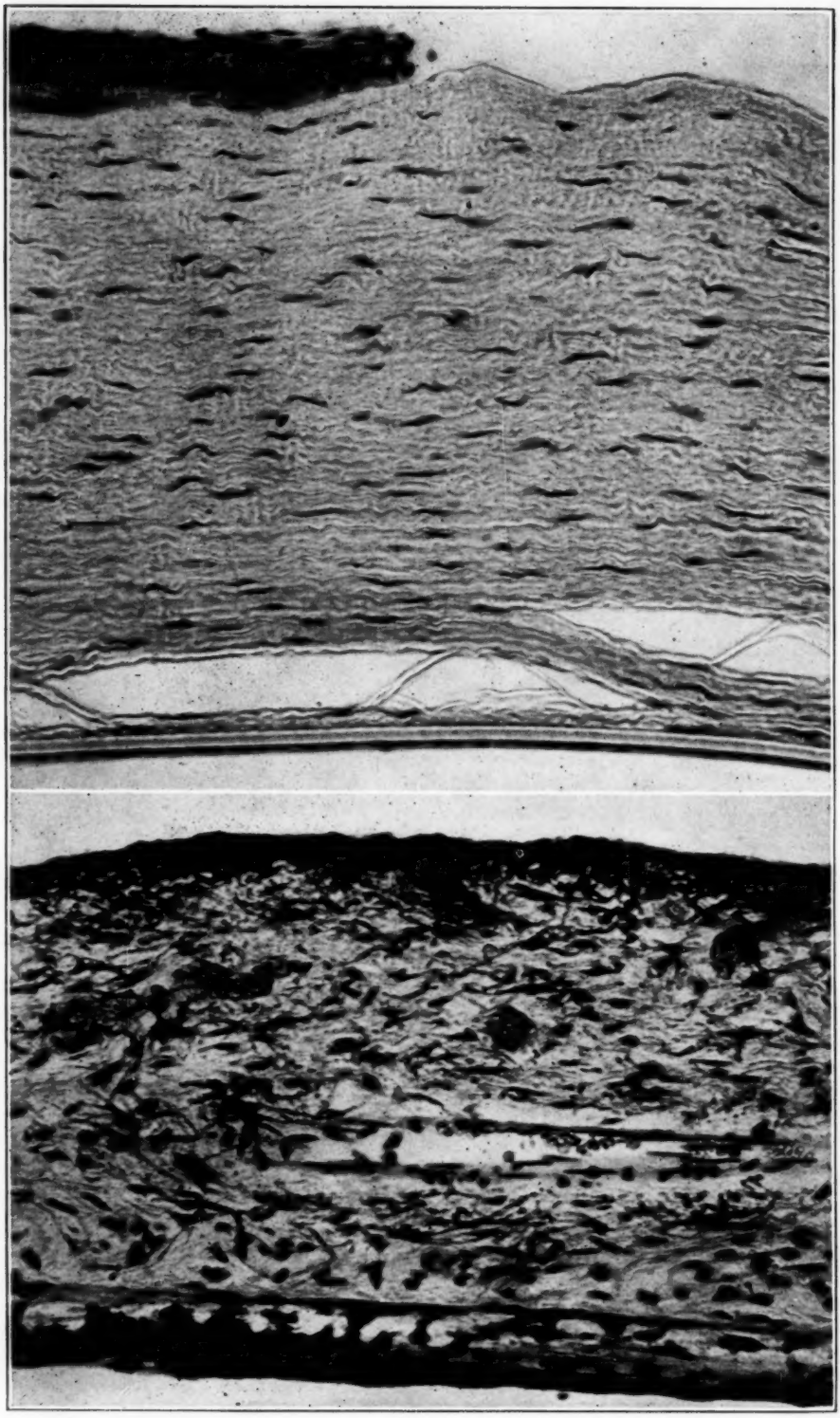

Fig. 3.—Cornea and iris of an untreated eye six hours after exposure to lewisite (0.4 mg.). Hematoxylin-eosin stain; magnification, 330.

7. Changes in the iris and ciliary body, consisting chiefly of congestion, cellular infiltration and dispersion of pigment

8. Alterations of the anterior chamber, consisting of deposition of serum and fibrin and cellular infiltration

9. Lenticular changes, ranging from vacuolation to permanent opacification

10. Reparative processes, consisting of newly formed capillaries and fibroblastic tissue

11. Evidences of secondary infection

These histologic events varied in extent in the case of each of the vesicant gases, depending on the following factors: (1) amount of vesicant agent and length of exposure; (2) toxicity of the individual gas (i. e., the severity of the changes will vary with the same concentration and time of exposure [C. T.] of the different gases); (3) length of time elapsing between exposure of the eye and enucleation. In the case of certain gases these changes occurred earlier than in others.

Detailed histologic studies were made of the course of ocular lesions due to lewisite burns in rabbits. These studies were performed on eyes burned by standard technics. Liquid lewisite, 0.4 mg., was delivered by microsyringe to the superior limbus, and the lids were allowed to close immediately. The two eyes of each rabbit were burned with the same dose of lewisite. One eye of each rabbit was treated with 5 per cent BAL in ethylene glycol two minutes after burning. The eyes were enucleated fifteen minutes, one hour, six hours, twelve hours, two days, three days, five days, ten days and fourteen days after exposure. All eyes were fixed in a dilute solution of formaldehyde U.S.P. and prepared for histologic study by the pyroxylin technic. The hematoxylin-eosin stain was used.

RESULTS OF HISTOLOGIC STUDY OF UNTREATED EYES

Within ten to fifteen minutes after exposure a definite histologic change could be noted in the cornea (figs. 1 and 2). This consisted of swelling of the epithelium with separation from the underlying stroma, representing early edema. During the first hour the process progressed; the epithelium was lost over some areas and showed edema of the basal cells with detachment in others. The fibers of the stroma were separated, and there were vacuolated areas about some stromal nuclei. These changes were indicative also of increasing corneal edema. A fine granular exudate appeared in the anterior chamber. The vessels of the iris and the ciliary body became slightly congested. The conjunctival vessels also were congested, and red blood cells and fibrinous exudate could be seen to have escaped into the conjunctival tissues.

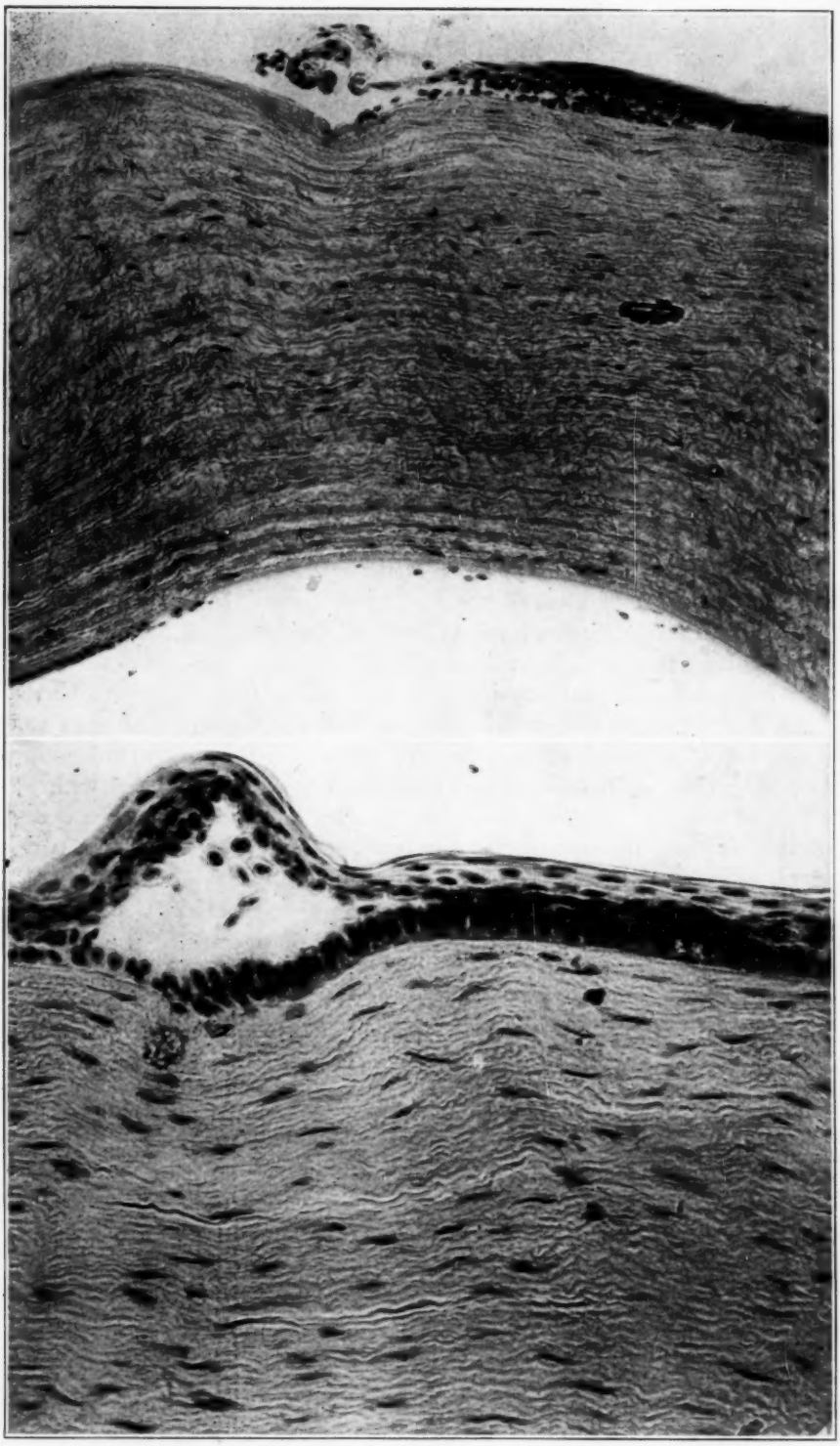

Fig. 4.—Corneas of untreated (above) and treated eyes six hours after exposure to lewisite (0.4 mg.). Hematoxylin-eosin stain, magnification of untreated cornea, 170: of treated cornea, 330.

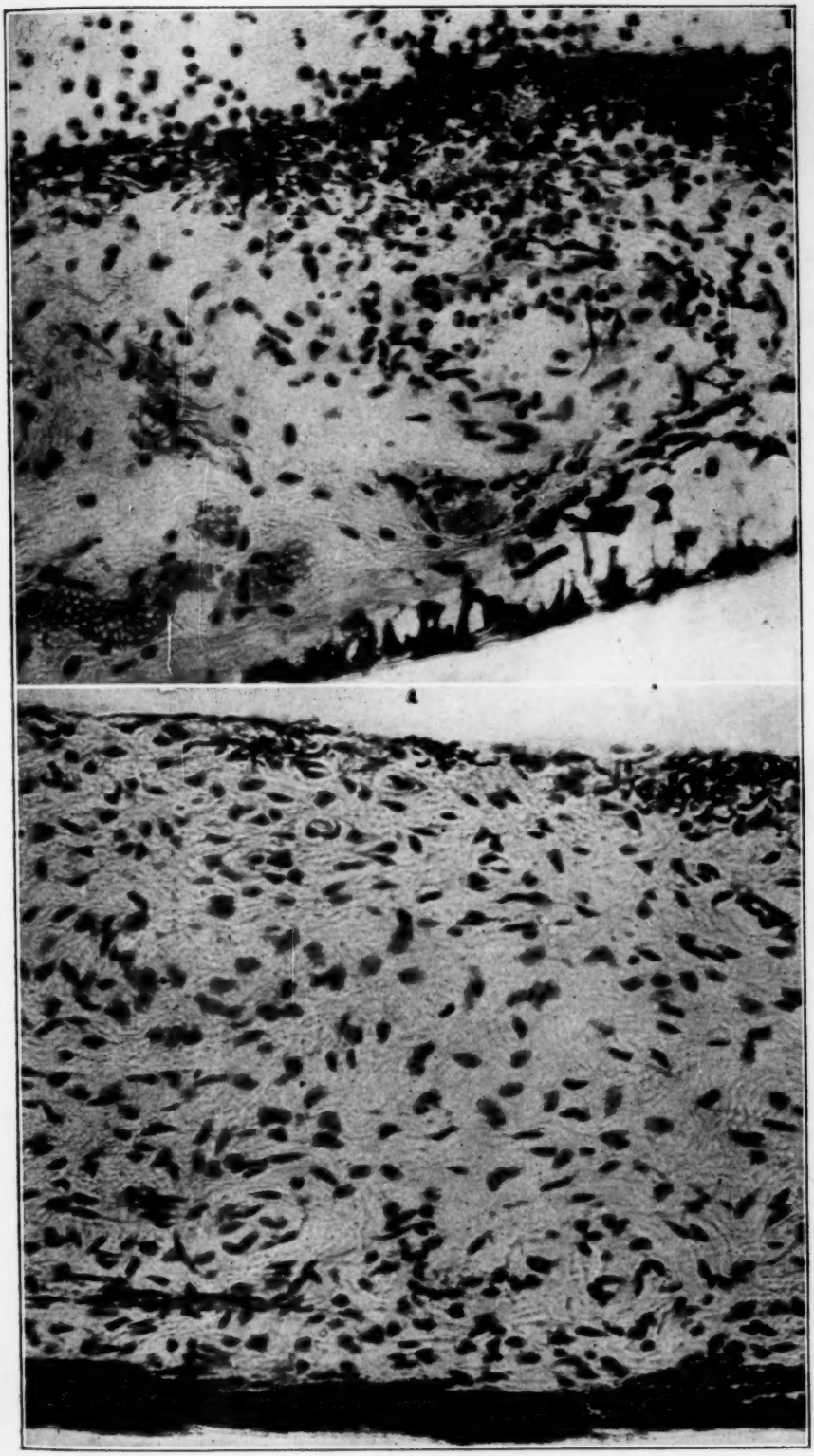

Fig. 5.—Irises of untreated (above) and treated eyes six hours after exposure to lewisite (0.4 mg.). Hematoxylin-eosin stain; magnification, 330.

Fig. 6.—Corneas of untreated (above) and treated eyes twelve hours after exposure to lewisite (0.4 mg.). Hematoxylin-eosin stain; magnification, 330.

At the end of six hours prominent pathologic changes had appeared in the whole anterior segment of the eye. The epithelium had entirely disappeared from most areas of the cornea. The conjunctiva showed considerable edema and extensive infiltration with polymorphonuclear leukocytes. In the stroma the number of nuclei was reduced, and the staining of all stroma was less than normal. Descemet's membrane was present, but the endothelium was partly lost. A scanty exudate containing polymorphonuclear leukocytes was observed in the angle of the anterior chamber and on the anterior surface of the iris. The iris and ciliary body showed edema, congestion and an occasional polymorphonuclear leukocyte. The rest of the eye was unchanged.

At the end of twelve hours the changes were similar to those seen at the end of the six hours but were much more intense. The most striking change was in the corneal stroma, where the staining properties were poor and the nuclei were scanty, a condition denoting beginning necrosis of stromal cells. In addition to the edema in the iris and the ciliary body, one observed exudate and areas of hemorrhage.

At the end of twenty-four hours, although all portions of the anterior segment were involved, the changes in the stroma were prominent. No nuclei were seen in the corneal stroma except near the limbus. The outlines of the stromal fibers were indistinct; the staining qualities were poor, and a polymorphonuclear cell infiltrate appeared at the limbus.

At the end of two days the lesions were still advancing. In addition to the necrotic changes previously noted in the stroma, there was now loss of both stroma and epithelium, producing severe ulceration. Polymorphonuclear cell infiltration was beginning to extend into the stroma from the limbus, and in general the stromal fibers were poorly demonstrated. Few stromal nuclei were present, and their staining reaction was poor. There was severe iridocyclitis, and the sclera now showed beginning infiltration.

At the end of three days the pathologic changes were similar to those noted at the end of two days and appeared to have reached their maximum short of corneal perforation.

At the end of five days the changes consisted of corneal ulceration, iridocyclitis and polymorphonuclear cell exudate, filling one-third to one-half the anterior chamber. Early, deep vascularization was seen in the stroma at the periphery of the cornea. Superficial vascularization was uncommon. Mild doses of lewisite may not produce vascularization until the seventh day. Edema of the ciliary processes and disturbance of iris pigment were clearly apparent at this stage. Epithelial regeneration, represented by a single layer of cuboidal cells, had usually begun.

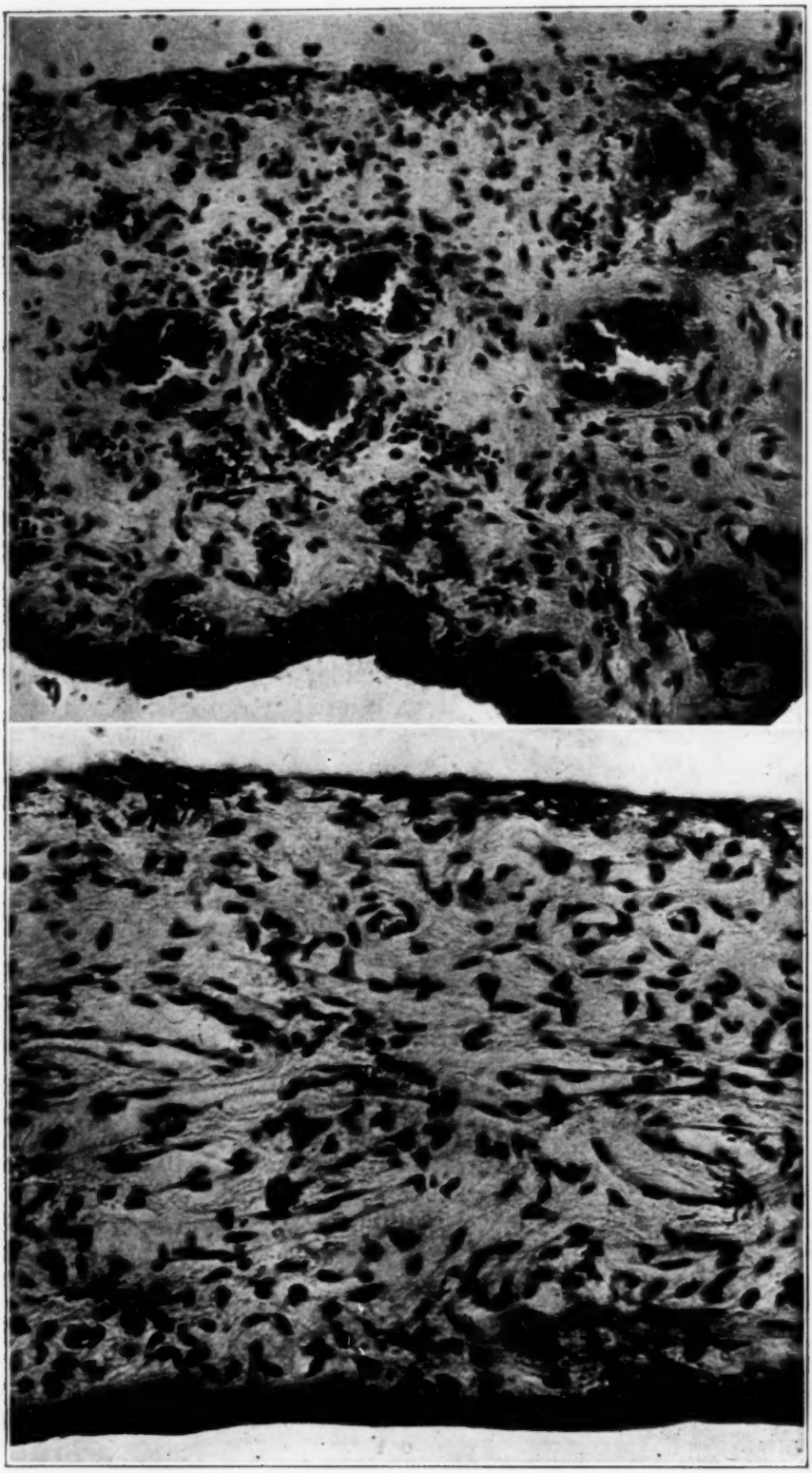

Fig. 7.—Irises of untreated (above) and treated eyes twelve hours after exposure to lewisite (0.4 mg.). Hematoxylin-eosin stain; magnification, 330.

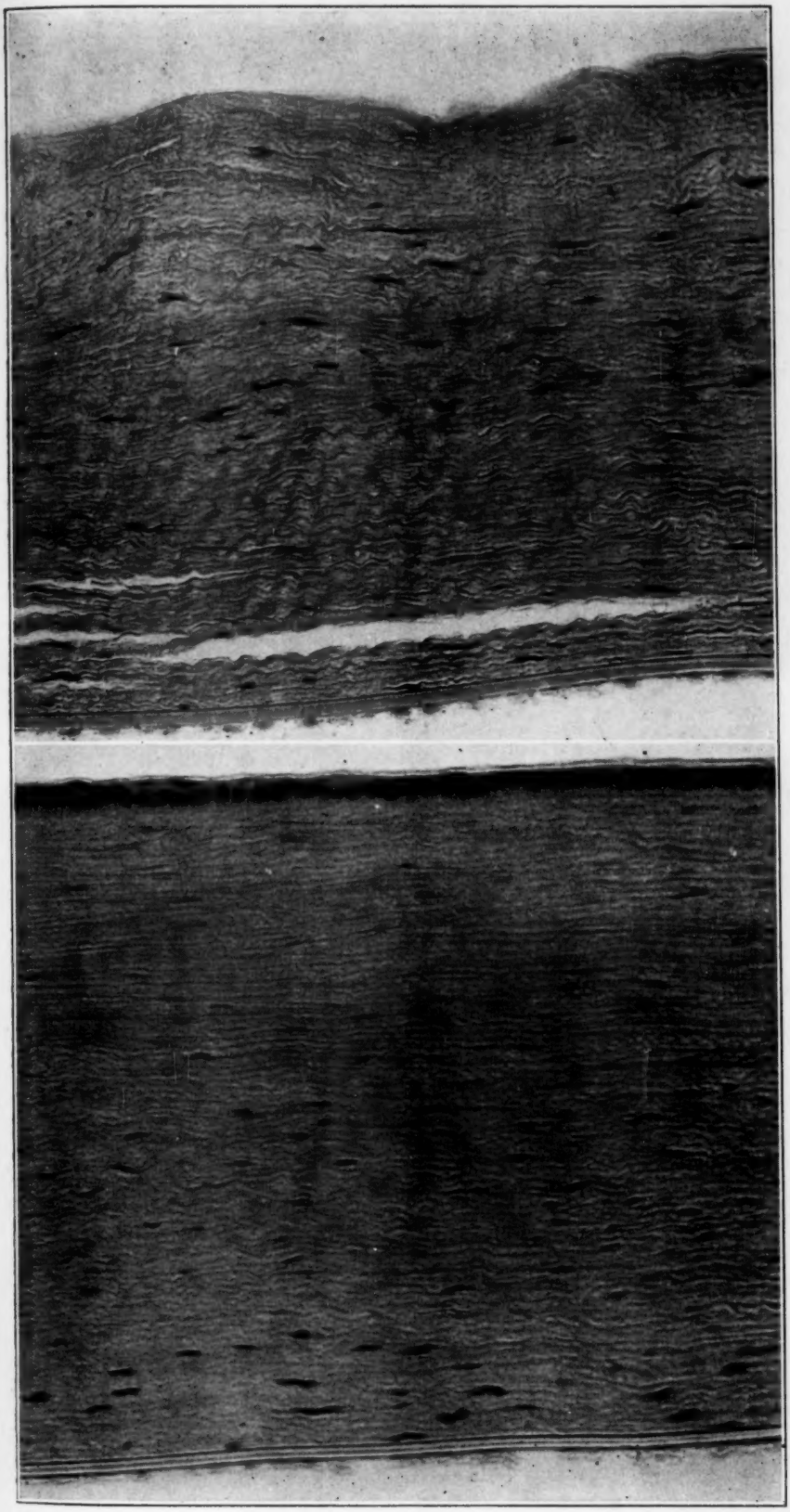

Fig. 8.—Corneas of untreated (above) and treated eyes twenty-four hours after exposure to lewisite (0.4 mg.). Hematoxylin-eosin stain; magnification, 330.

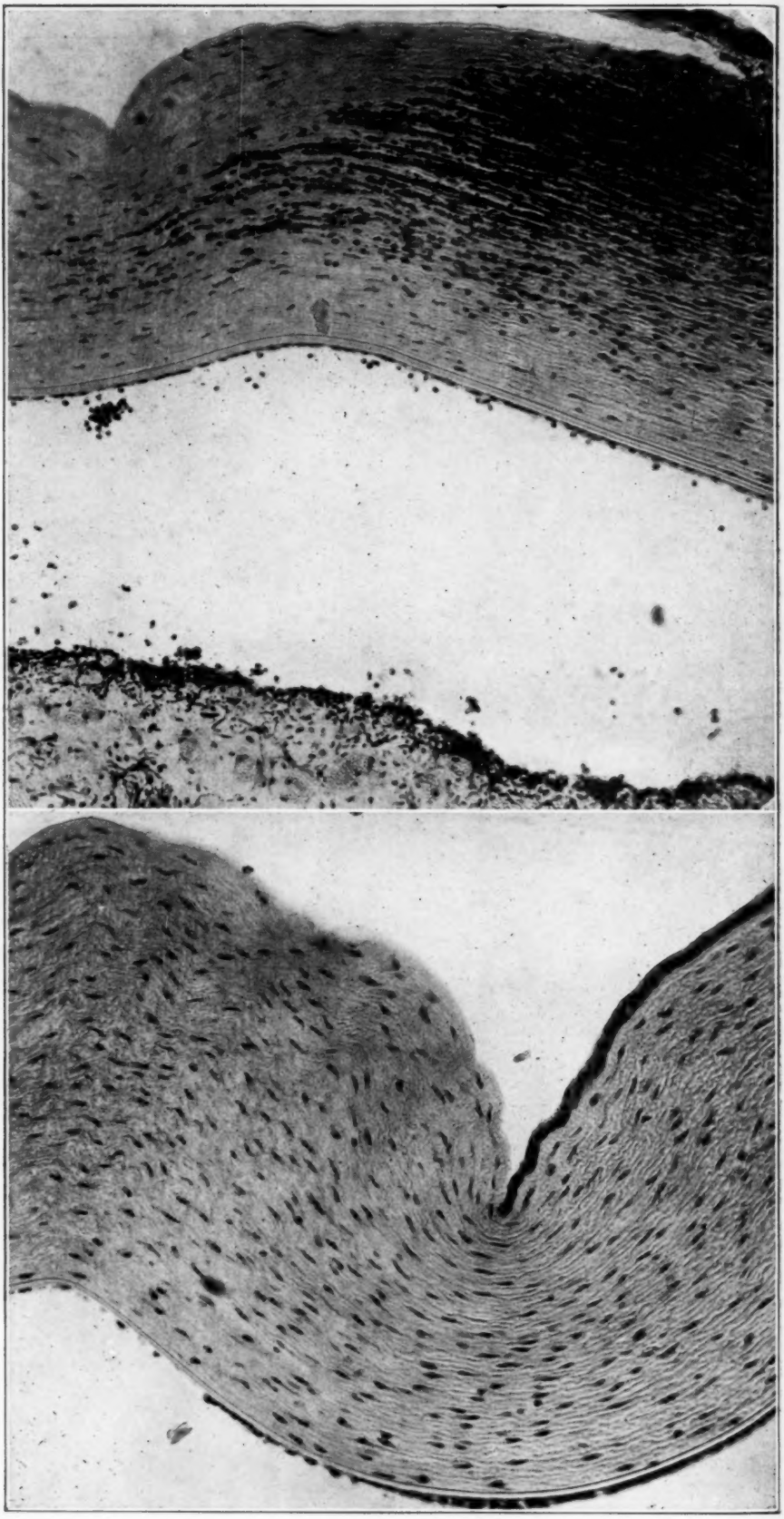

Fig. 9.—Fields from the same corneal sections as those shown in figure 8, but closer to the limbus.

By the seventh to the tenth day, in eyes which had not already perforated, some evidence of repair was present. The eye still showed evidence of severe inflammation of the anterior segment. The chief indications of repair were the presence of an irregular epithelium, varying from two to six layers in thickness, and the presence of capillaries throughout the infiltrated areas of the stroma. Regeneration of endothelium was noted by the seventh day. There was no edema of the conjunctiva. In the stroma the polymorphonuclear cell infiltrate was replaced almost entirely by a dense round cell infiltration. Fibro-

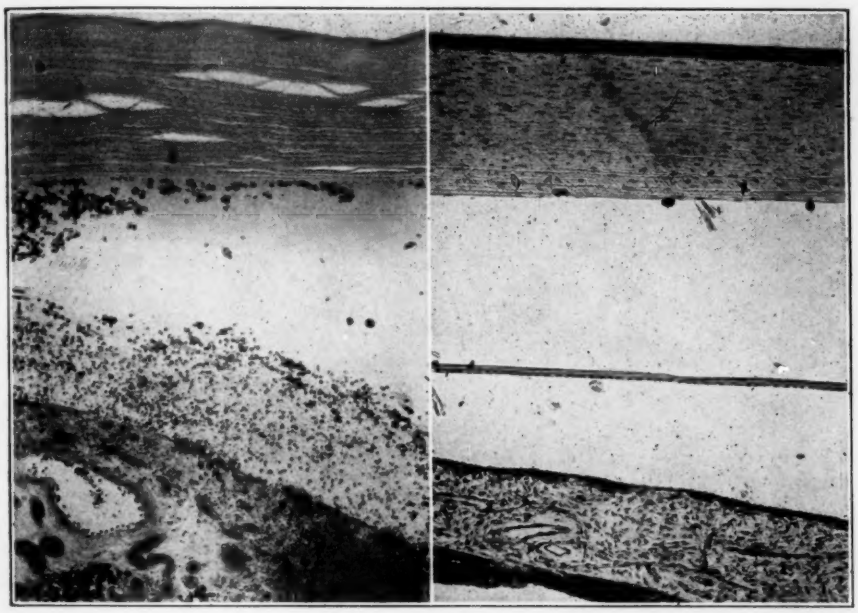

Fig. 10.—Cornea, iris and anterior chamber of untreated (left) and treated eyes forty-eight hours after exposure to lewisite (0.4 mg.). Hematoxylin-eosin stain; magnification, 60.

blasts were present in the deeper layers of the stroma. The exudate in the anterior chamber was beginning to clear, and what remained consisted of round cells. Peripheral anterior synechias were beginning to form. The iridocyclitis was less acute. The iris was usually shortened and thickened.

At the end of fourteen days eyes which previously had had small corneal perforations, now closed, showed evidence of repair similar to that at the end of ten days. The cornea was completely covered by an irregular layer of deeply staining epithelial cells. There was

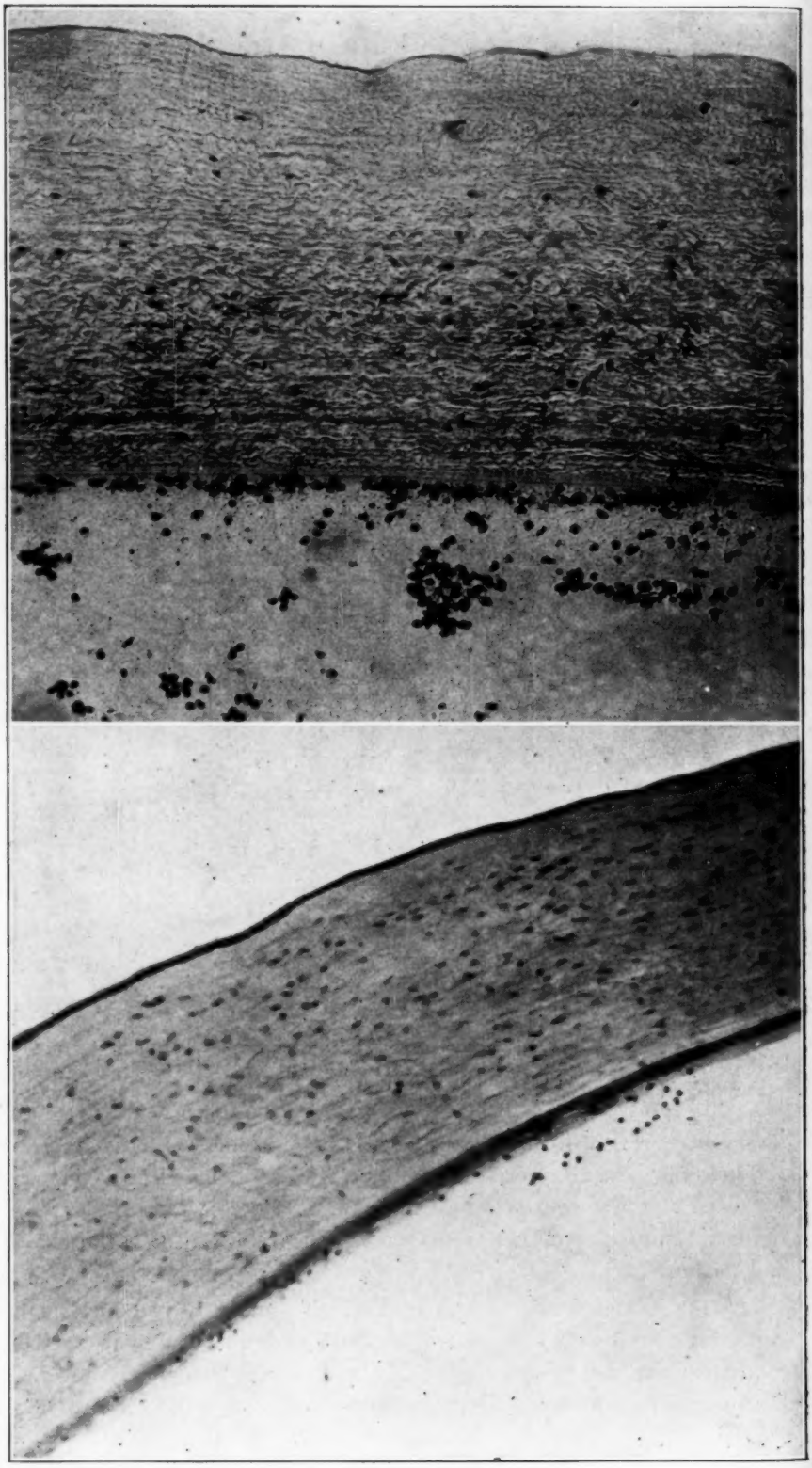

Fig. 11.—Corneas of untreated (above) and treated eyes seventy-two hours after exposure to lewisite (0.4 mg.). Hematoxylin-eosin stain; magnification of untreated cornea, 170; of treated cornea, 130.

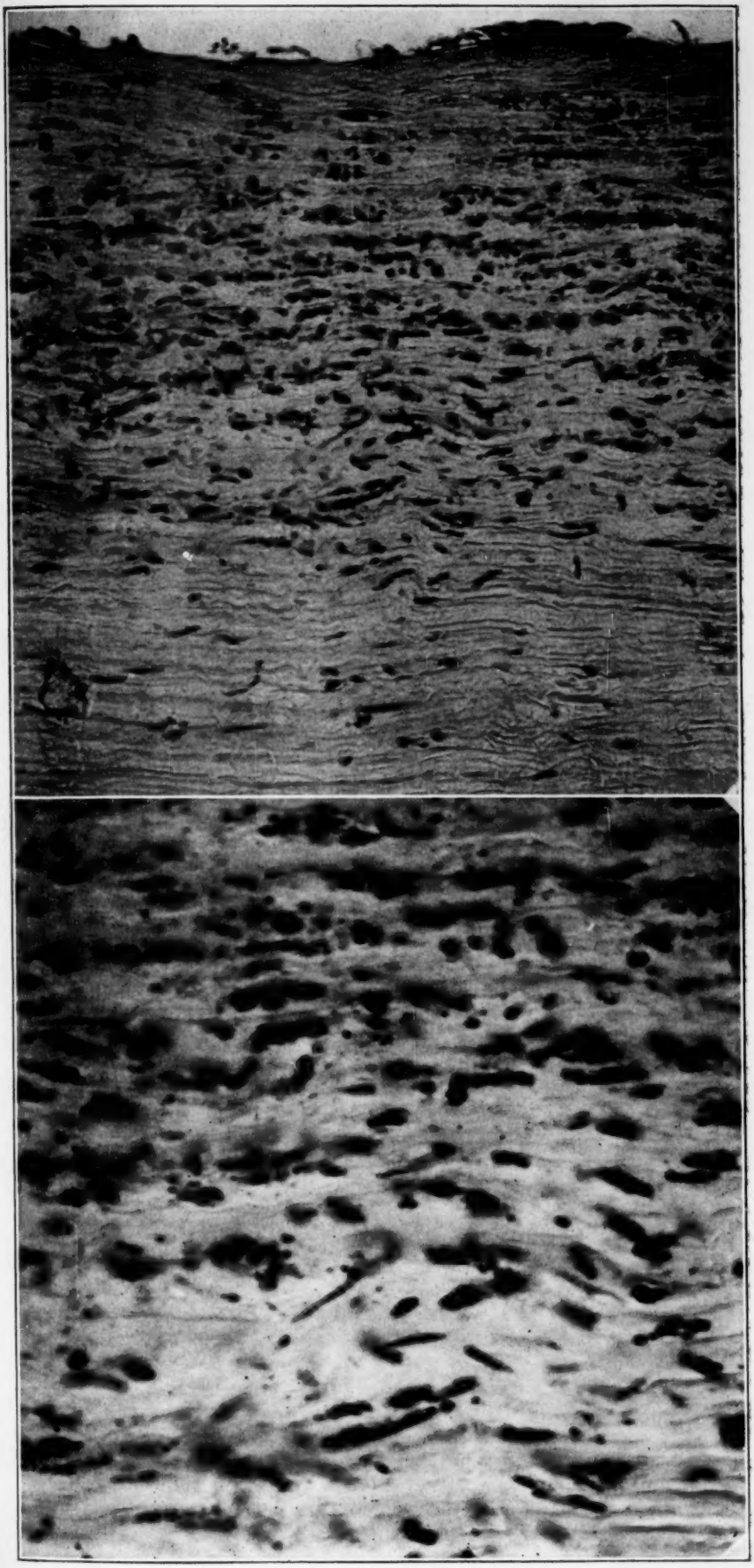

Fig. 12.—Untreated cornea five days after exposure to lewisite (0.4 mg.).

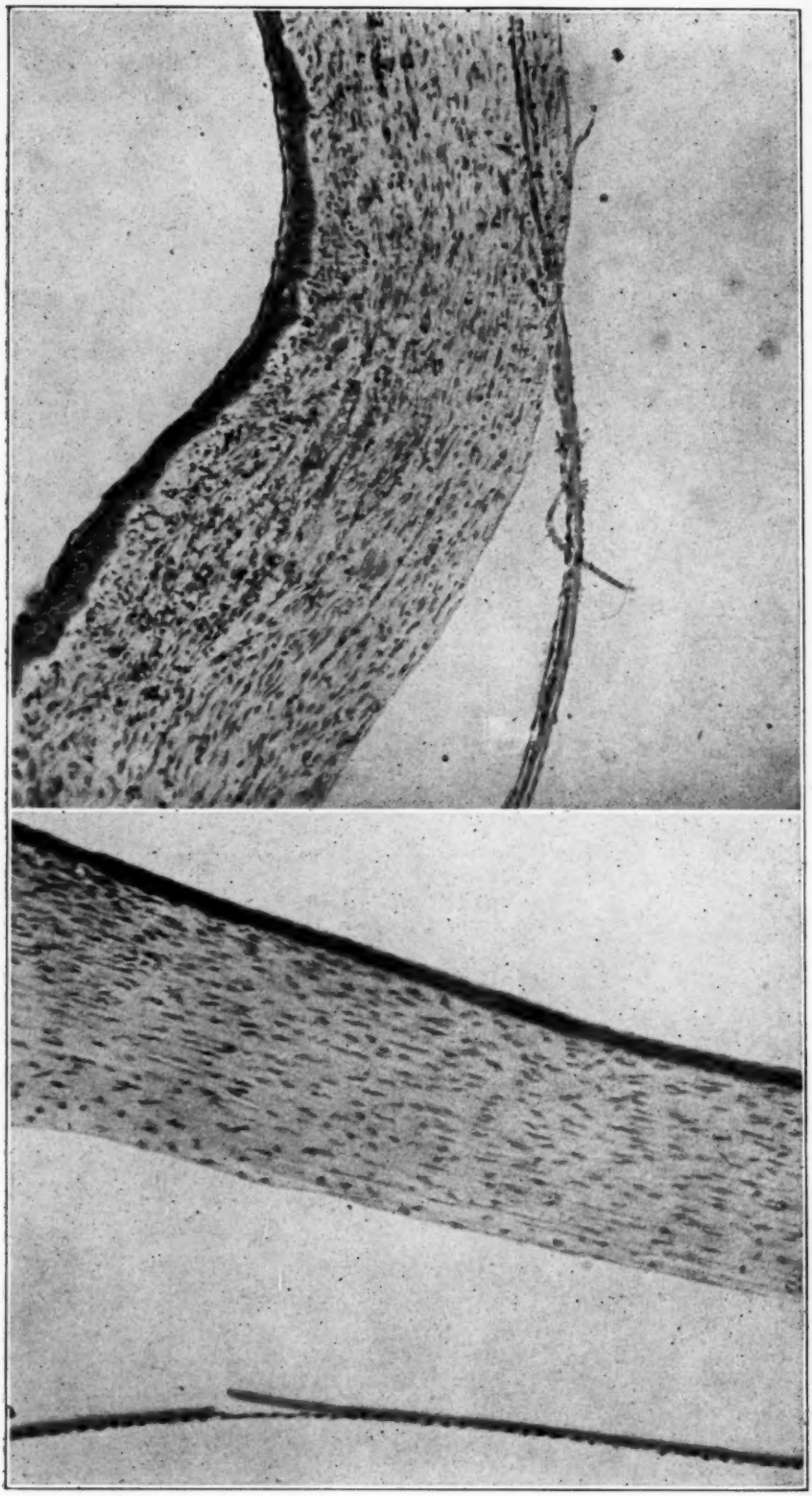

Fig. 13.—Corneas of untreated (above) and treated eyes ten days after exposure to lewisite (0.4 mg.). Hematoxylin-eosin stain; magnification, 170.

no conjunctival edema, but the subconjunctival tissue was thickened by fibroblasts. The stroma consisted of irregular bands and islands of round cells. In the middle layers were numerous small and medium-sized vessels. Although the anterior chamber was shallow, there were extensive peripheral synechias. The iris consisted of poorly staining fibroblasts and contained cells in which there was usually much phagocytosed pigment. In the posterior portion of occasional eyes foci of retinochoroiditis were noted.

INFLUENCE OF SPECIFIC THERAPY ON OCULAR LESIONS DUE TO LEWISITE

The standard severe ocular lesions produced by lewisite were treated with BAL and studied histologically. These lesions were compared with the untreated lesions described in the preceding [2b] section (figures). These studies showed that the changes in the cornea, the anterior chamber, the ciliary body, the lens and the rest of eye were less severe in the treated than in the untreated eyes. The difference in amount of inflammatory change was evident in twelve hours and continued to be apparent up to fourteen days. At the end of fourteen days, however, there were still changes in the corneal stroma of the treated eye. These changes consisted chiefly in an increase in stromal cells and fibroblasts and in the occasional vascularity of the limbus. The incidence of these scars was proportional to the concentration of vapor or liquid lewisite used to produce the ocular lesion and was inversely proportional to the length of time before application of BAL. In a treated eye there were no changes that could be attributed specifically to the treatment. The changes were similar to those observed in the untreated eye but were of milder degree.

SUMMARY

Several features of the pathologic changes in the rabbit eye injured by lewisite (β-chlorovinyldichloroarsine) may be emphasized:

1. In the early stages changes appeared in the stroma which may be interpreted as a rapidly progressing necrosis of the whole stromal layer. This was seen in the loss of the nuclei of the corneal fibers, the loss of staining ability of these fibers and their loss of outline. These changes were first seen at the end of six hours and reached the maximum in twenty-four hours.

2. The infiltration of the stroma began at the periphery at the twenty-four hour stage and was of polymorphonuclear cell type. This infiltrate was replaced by a round cell infiltrate at the end of the ten day stage.

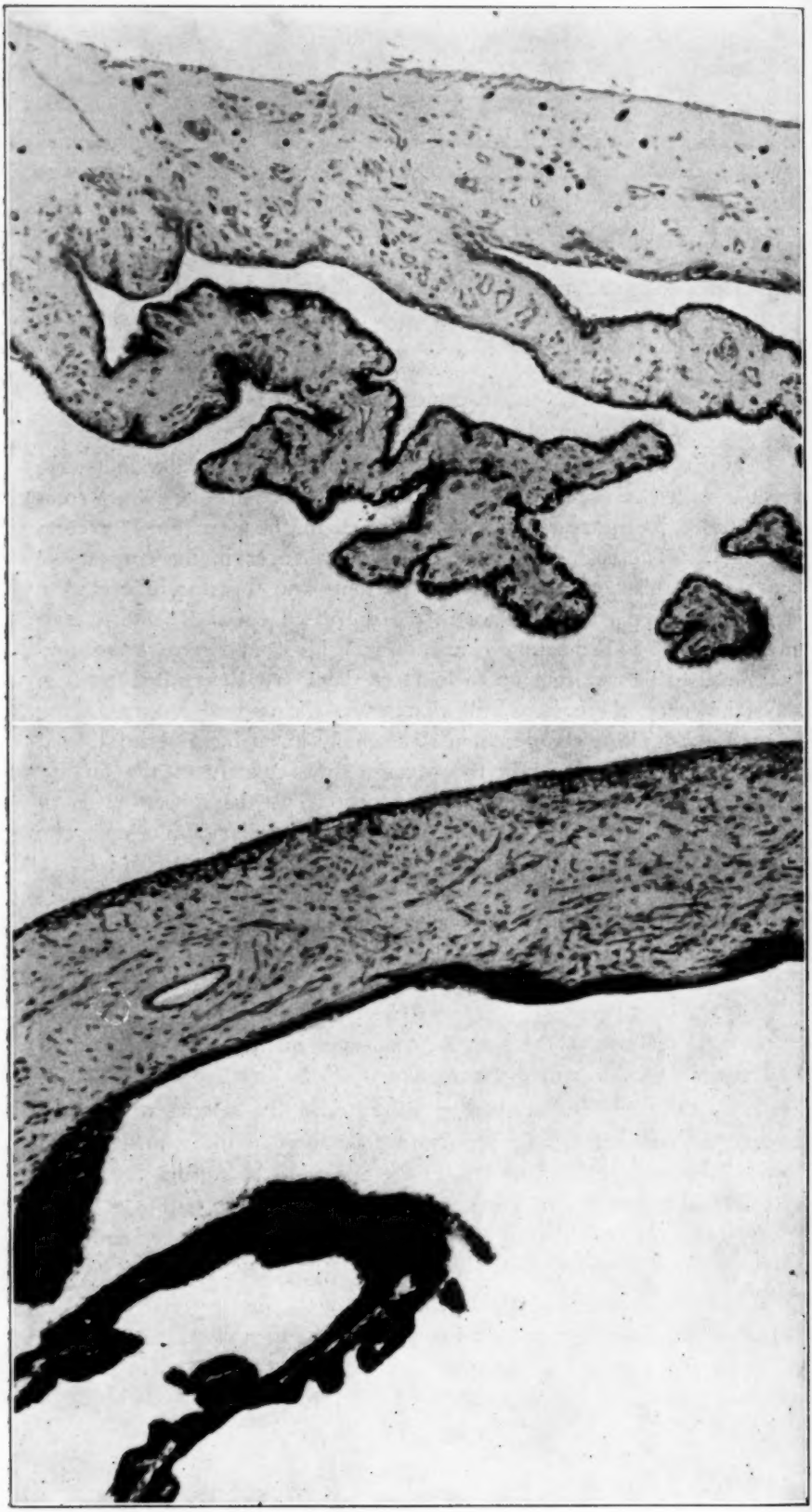

Fig. 14.—Irises of untreated (above) and treated eyes from the same eyes as those in figure 13; magnification, 170.

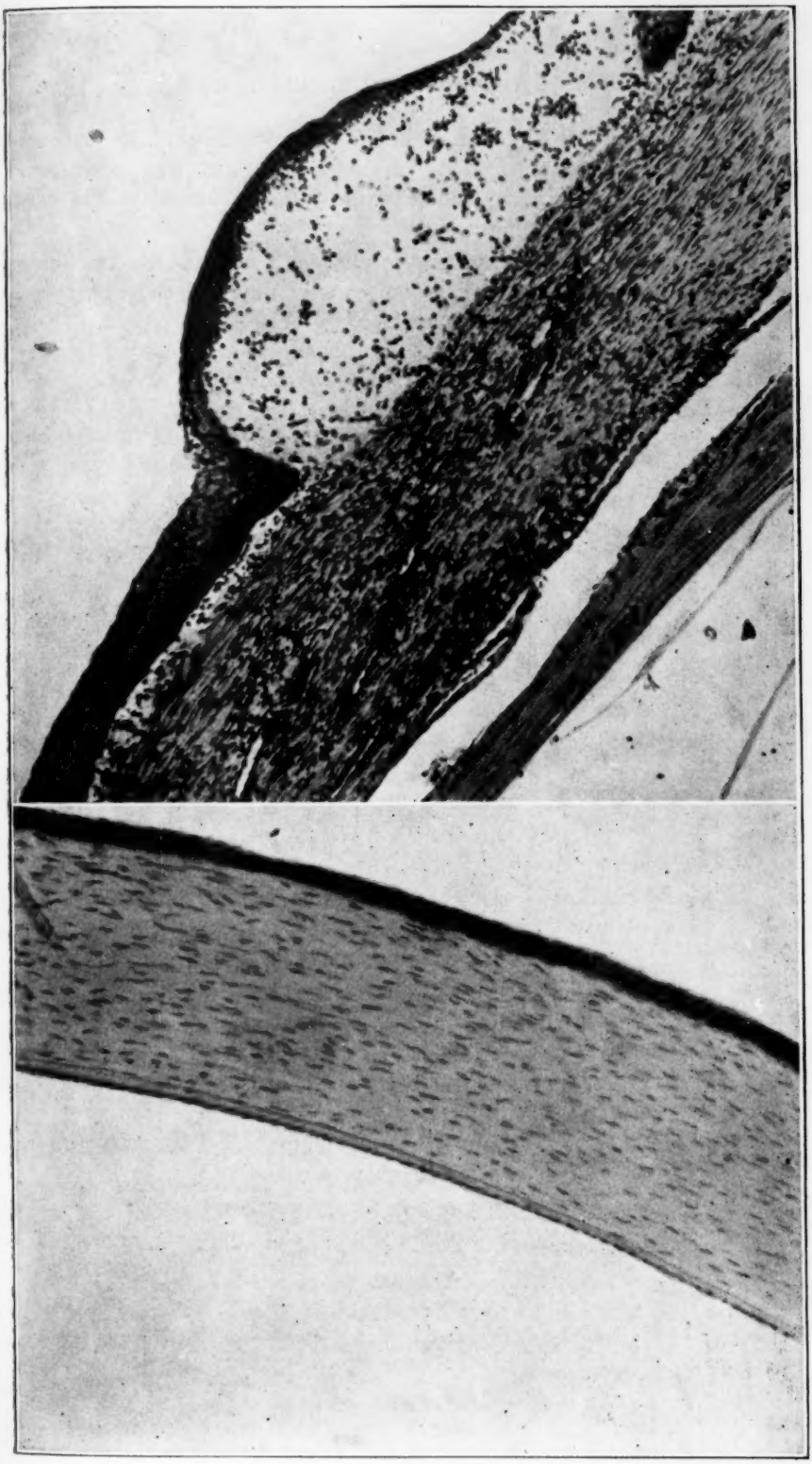

Fig. 15.—Corneas of untreated (above) and treated eyes fourteen days after exposure to lewisite (0.4 mg.). Hematoxylin-eosin stain; magnification of untreated cornea, 170; of treated cornea, 130.

3. Vascularization did not make its appearance until the end of five days. This vascularization was in all layers of the stroma but was most prominent in the middle layers. In fourteen days the vascularization was fairly intense.

4. In a treated eye there were no changes that could be attributed specifically to the treatment. The changes were similar to those observed in the untreated eye but were of milder degree.

Hospital of the University of Pennsylvania.

Clinical Notes

STUDENTS' MODEL FOR SLIT LAMP BIOMICROSCOPY OF THE AQUEOUS HUMOR

W. MORTON GRANT, M.D., BOSTON

FOR FAMILIARIZING students with the biomicroscopic appearance of the normal and the abnormal aqueous humor a series of model eyes is of considerable value. The type of model which I have found satisfactory in postgraduate teaching, and which others may similarly find useful, has a convex glass "cornea," a rubber "iris" and a glass "lens," with an "anterior chamber" which can be filled with various artificial "aqueous humors."

The "eye" is constructed from a 5 cc. round bottom Pyrex microbeaker, a one hole no. 2 rubber stopper and a piece of 5 mm. glass rod. The rubber stopper is freed of talc and shortened to 13 mm. by removing a slice from the large end with a knife. The stopper is then pushed small end first as far as it will go into the microbeaker. A space approximating the anterior chamber in shape remains between the round bottom of the beaker and the end of the stopper. Artificial aqueous is introduced into this space through the hole in the stopper by means of a pipet. The hole is then plugged with a 30 mm. length of 5 mm. glass rod having one end rounded by heating. The round end of the rod is pushed into the hole until it becomes flush with the inner end of the stopper. The completed eye is held by a clamp on a ring stand at a convenient height for inspection with the slit lamp microscope.

The following aqueous preparations have been found satisfactory: (1) distilled water, to simulate normal aqueous, giving an appearance of an "optically empty" anterior chamber; (2) diluted plasma with protein concentrations of 0.2 and 2 per cent to present different intensities of the Tyndall effect; (3) dilute suspension of red blood cells in isotonic solution of sodium chloride; (4) suspension of cholesterol crystals, produced by adding an acetone solution of cholesterol to a relatively large volume of water, and (5) a suspension of diatomaceous earth. The last preparation is convenient for demonstration of the characteristic motion of particulate matter in the anterior chamber, which is caused by thermal convection currents. These currents are usually set up in the model merely by the heating effect of the examining light on the "iris"; if this is insufficient, the convection currents may be induced by first warming the model under the hot water faucet.

The model eye described here affords a considerably more realistic optical setting for the inspection of the aqueous humor than do plane-surfaced cells or simple test tubes, which my associates and I had previously employed. Reflections are more like those of the eye, and

From the Howe Laboratory of Ophthalmology, Harvard Medical School, and the Massachusetts Eye and Ear Infirmary.

the presence of an "iris" permits inspection by transillumination. This model is a useful adjunct to enucleated cattle eyes, which are employed in study of the appearance of the cornea.

243 Charles Street.

EXACT SURFACE LOCALIZATION OF OPHTHALMOSCOPICALLY VISIBLE FOREIGN BODIES IN THE VITREOUS CHAMBER

WALTER S. ATKINSON, M.D., WATERTOWN, N. Y.

SMALL foreign bodies in the vitreous chamber which are entangled in the retina and choroid or embedded in the sclera are often not pulled loose with the magnet unless it is applied close to or directly over the foreign body.

The danger is that the foreign body may be incorrectly considered nonmagnetic after a number of unsuccessful attempts to remove it.

The case reported here is one in which this error was made.

J. L. A., a mechanic aged 38, was first seen Oct. 6, 1933. The day before, he had been pounding a piece of metal with a hammer and something flew up and struck him in the left eye. Examination showed vision of 20/15—1 in the right eye and 20/15—3 in the left eye. The conjunctiva was congested, but no wound was seen in the conjunctiva or cornea.

On ophthalmoscopic examination a metallic-looking foreign body was clearly seen embedded in the retina. The location of the foreign body was estimated with the ophthalmoscope to be 15 mm. back of the corneal margin and a little below the 180 degree meridian. Further roentgenographic localization was not considered necessary.

A small scleral incision was made 15 mm. posterior to the corneal margin and several millimeters below the lateral rectus muscle, as it was not thought necessary to make it directly over the foreign body. Repeated attempts with both the Lancaster hand and the giant magnet failed to withdraw the foreign body.

Ophthalmoscopic examination after the use of the magnets showed the foreign body in the same location and the scleral incision about 7 mm. below the foreign body, which was considered close enough to attract a magnetic foreign body 1.5 by 0.75 by 0.50 mm. in size. Consequently, it was thought to be nonmagnetic.

On October 24, eighteen days later, the patient brought to the office the metal he had struck with the hammer at the time of his injury, and it was found to be magnetic.

The foreign body was then watched with the ophthalmoscope by the indirect method while a magnet was applied to the eye. The foreign body could be seen to jump forward a few millimeters each time the current was turned on, showing it to be magnetic. Evidently, application of the magnet to an incision in the sclera 7 mm. from the foreign body is not near enough to withdraw it if it is entangled in the tissues. Repeated attempts with both the hand and the giant magnet failed to dislodge the foreign body so that it could be drawn into the anterior chamber.

On October 30, a small pin, similar to a Safar or Walker pin, as used for retinal detachments, was introduced at the estimated site of the foreign body, and ophthalmoscopic examination showed it to be 0.5 mm. from and directly above the foreign

body. A scleral incision was then made just below the pin and the foreign body removed with the magnet on the first application.

The patient was last seen on July 2, 1935, at which time the eyes were quiet and vision was 20/15—1 each eye.

Since then the same procedure has been employed for accurate surface localization of ophthalmoscopically visible foreign bodies in the vitreous chamber, with equally satisfactory results.

129 Clinton Street.

MASSIVE MELANOSARCOMA OF THE EYE

LEE W. HUGHES, M.D., and ANTHONY AMBROSE, M.D., NEWARK, N. J.

THIS case is recorded not so much for its pathologic interest, because the tumor is one of the common ones affecting the eye, but for its photographic value. Patients are often seen who have put up with the inconvenience of large tumors in the abdomen and on various parts of the body where they are not exposed. One would hardly imagine enduring a tumor such as this one, which was not at all pleasant to look at.

Massive melanosarcoma of the eye.

REPORT OF A CASE

The patient was a frail white woman aged 74. A reliable history could not be obtained from the patient nor her family. The growth had been present in the form seen in the photograph for at least one year. "She noticed a growth on the left eye, which gradually enlarged and later started to bleed." At times the bleeding was considerable. She kept the tumor covered with tissue paper.

On Oct. 13, 1945 she was admitted to the Newark Eye and Ear Infirmary. There were pronounced secondary anemia and weakness. The mass protruding from the left eye was the size of a goose egg; it was secondarily infected, had a foul odor, bled easily and was a combination of black, blue, green and red colors.

Operation was performed on October 15. Exenteration of the left orbit was done with the Bovie electric knife, the patient being under pentothal anesthesia. There was only moderate bleeding. The brow and the part of the upper lid were left. None of the structures of the orbit could be identified except the sclera, and at one point some dark, blood-stained vitreous was cut through. The orbit was cleaned out completely; the various fissures were palpated, and no extension of the growth could be felt or seen. No vessels had to be tied. The cavity was packed with iodoform gauze. The patient made an uneventful recovery. A photograph taken four months after operation showed almost the entire orbit closed over with skin, with only a very small aperture. There has been no local recurrence or general metastasis to date; the patient has gained weight, and her general health is now good.

It was impossible to get the early history of the ocular trouble, although it was definitely stated that the growth did not originate either in the lids or in the conjunctiva.

The pathologic report was melanosarcoma, made by our own laboratory and by Dr. J. A. Ash, of the Army Institute of Pathology, who expressed the belief that the origin of the tumor was in the eyeball.

965 Broad Street (2).

31 Lincoln Park (2).

News and Notes

EDITED BY DR. W. L. BENEDICT

GENERAL NEWS

Heed Ophthalmic Foundation—The Heed Ophthalmic Foundation offers a limited number of fellowships for advanced training in ophthalmology.

Only candidates who have completed a minimum of two years' specialized study in ophthalmology are eligible.

United States citizenship is required.

Application blanks and additional information may be obtained from the secretary of the board of directors, Dr. M. Hayward Post, 520 Metropolitan Building, 508 North Grand Boulevard, St. Louis 3.

The first fellowship, to be known as the Gradle Fellowship, has been given to Dr. John C. Poore, now finishing his residency at the University of California Medical School, and the second, to Dr. Herbert B. Shields, who is in a like position at Washington University School of Medicine, St. Louis.

Twelfth National Assembly of the United States Chapter of the International College of Surgeons.—The Twelfth National Assembly of this organization will be held from Sept. 28 to Oct. 4, 1947, at the Palmer House, in Chicago. Prof. Ignacio Barraquer, of Barcelona, Spain, will speak on his technic for cataract extraction. There will be demonstrations and clinics on ophthalmic surgery. The chairman is Dr. Oscar B. Nugent, 231 West Washington Street, Chicago, and the secretary is Dr. Otis R. Wolfe, Evangelical Deaconess Home and Hospital, Marshalltown, Iowa.

Third Pan-American Congress of Ophthalmology.—The date of the Third Pan-American Congress of Ophthalmology has been changed to January 4 to 10, 1948, inclusive, owing to the difficulty in arranging hotel accomodations in February.

The Congress will be directed by a local committee. Dr. Tomás R. Yanes is the president; Dr. Gilberto Cepero, general director, and Dr. Miguel A. Branly, general secretary.

The official program has been definitely closed, and authors should send in their papers, accompanied with a résumé of 400 to 600 words, before Aug. 23, 1947, to Dr. Tomás R. Yanes, Apartado Postal 970, Habana, Cuba, with a copy to Dr. Miguel A. Branly, Edificio Bacardí, Habana, Cuba, and another copy to the secretary of the association, Dr. Conrad Berens, 301 East Fourteenth Street, New York 3, if resident north of Panama, or to Dr. Moacyr E. Alvaro, 1151 Rua Consolação, São Paulo, Brazil, if resident south of Panama.

The Congress will be held in the building of the Medical School of the University of Habana.

Dr. Thomas D. Allen, 122 South Michigan Avenue, Chicago 3, is the director of the courses of instruction. Dr. Brittain F. Payne, 301 East Fourteenth Street, New York 3, is the director of the scientific exhibition.

Firms interested in renting space for the commercial exhibit should write to Mr. Hector Uribe Troncoso, 301 East Fourteenth Street, New York 3.

Hotel reservations should be made through Dr. Miguel A. Branly, Edificio Bacardí, Habana, Cuba, and requests should be accompanied by $10, the amount of the Congress dues. Should a member be unable to attend the meeting, his dues give him the right to receive the *Transactions* of the Congress. Registrations are accepted from this date, and prospective members are advised to make reservations immediately.

Any additional information may be obtained from the general secretary, Dr. Miguel A. Branly, Edificio Bacardí, Habana, Cuba.

PERSONAL NEWS

Bequest to University of Alabama School of Medicine.—Dr. Charles A. Thigpen, of Montgomery, distinguished Alabama ophthalmologist for the past fifty years, has presented to the University of Alabama School of Medicine the sum of $10,000, to be used for the conversion of one floor of the Jefferson Hospital into a complete ophthalmic hospital, with operating rooms, laboratory, clinic, residents' quarters and bed space for patients.

This gift is in memory of his late nephew, Dr. Job T. Cater, who was associated with him in practice. The unit will be known as the Thigpen-Cater Ophthalmic Hospital.

Appointment of Dr. Albert D. Ruedemann.—Dr. Albert D. Ruedemann, formerly chief of service, the Cleveland Clinics, has been appointed professor of ophthalmology at Wayne University College of Medicine.

Abstracts from Current Literature

EDITED BY DR. WILLIAM ZENTMAYER

Blind

A STATISTICAL ANALYSIS OF PERSONS CERTIFIED BLIND IN SCOTLAND. R. M. DICKSON, Brit. J. Ophth. **30:** 381 (July) 1946.

The analysis comprises the regional clinics for Edinburgh, Dundee, Dumfries, Aberdeen and Inverness for the period from November 1930 to the end of 1938. A total of 5,953 persons were examined by ophthalmologists, and 4,078, or 68.5 per cent, were certified as blind within the meaning of the Blind Persons Act. Visual standards in Scotland fall into three categories: (1) visual acuity of less than 3/60 Snellen, regarded as blindness, (2) visual acuity of 6/60 Snellen or better, not regarded as blindness unless the field of vision is contracted to 10 degrees or less throughout the greater part of its extent, particularly in the lower part of the field; (3) intermediate degrees of visual acuity, i. e., 3/60 Snellen but less than 6/60, regarded as blindness (*a*) when the visual defect is associated with a restricted field of vision, although it exceeds the limit of 10 degrees laid down in *2* and (*b*), when the eye is aphakic. The chief causes of blindness were cataract, 17.1 per cent; myopia, 14.9 per cent; chronic septicemia, 10.8 per cent; syphilis, 10 per cent, glaucoma, 8.1 per cent, and injury, 5.9 per cent. A new significance is given to causes operating in the early years of life; the most important causes from this point of view are chronic septicemia, congenital anomalies, ophthalmia neonatorum and congenital syphilis, which together account for 44.5 per cent of the total duration "patient years" of blindness. Cataract, the cause of the greatest number of cases, is relegated to seventh place, with an average of five years of blindness. Miners, metal workers and spinners and weavers have a higher than average incidence of blindness. When cases of traumatic blindness are omitted, the total incidence of blindness is about the same in the two sexes.

W. ZENTMAYER.

Congenital Anomalies

A CASE OF SECONDARY OBLIQUE FACIAL CLEFT. A. MELLICK, Brit. J. Ophth. **30:** 221 (April) 1946.

A man aged 20 presented in the left eye a narrow bridge of skin passing down from the upper lid in the region of the lacrimal punctum to become continuous with the semilunar fold. In the center of the bridge of skin, in the line of the upper lid margin, there was a small depression, which admitted a fine horsehair in a medial direction for a distance of about 1.5 mm. The lower lid showed a slight degree of notching between the inferior punctum and the inner canthus. There were no other abnormalities of the eye. The right eye was normal. It is assumed that adhesion or pressure of amniotic bands is the cause of this anomaly.

The article is illustrated.

W. ZENTMAYER.

Cornea and Sclera

INDICATIONS AND CONTRAINDICATIONS FOR KERATOPLASTY AND KERATECTOMIES. R. CASTROVIEJO, Am. J. Ophth. **29**:1081 (Sept.) 1946.

Castroviejo concludes that keratoplasty and keratectomy are no longer procedures of uncertain results and that further study may permit opening a larger field for this type of surgery. W. S. REESE.

CORNEAL ULCER TREATED WITH STREPTOMYCIN. N. F. ALBERSTADT and A. H. PRICE, Am. J. Ophth. **29**:1106 (Sept.) 1946.

Alberstadt and Price found streptomycin, a nontoxic antibiotic derived from Actinomyces griseus, to be a useful adjuvant in the treatment of corneal ulcer. W. S. REESE.

KERATOCONJUNCTIVITIS SICCA. J. M. RICHARDS and H. H. ROMAINE, Am. J. Ophth. **29**:1121 (Sept.) 1946.

Richards and Romaine present a case of the purulent conjunctival form of erythema exudativum multiforme (Stevens-Johnson disease) and note the association of keratoconjunctivitis sicca with this disease. Emphasis is placed on the dire ocular sequelae. W. S. REESE.

EDEMA OF CORNEAL EPITHELIUM CAUSED BY ATABRINE [QUINACRINE]. F. M. REESE, Bull. Johns Hopkins Hosp. **78**: 325 (June) 1946.

Reese presents records of 3 patients who complained of severe blurring of vision while taking 0.2 Gm. of quinacrine hydrochloride a day. One patient had received a larger therapeutic course of quinacrine twenty-one days previously; the second had received therapeutic courses of the drug repeatedly for almost two years up to two months previously, and the third patient had received 0.2 Gm. of quinacrine hydrochloride a day for twenty-seven days up to nine days before admission. Examination of the eyes of these patients showed edema of the corneal epithelium, "bedewing" of an unusually fine texture and uniform appearance with the slit lamp. All 3 soldiers appeared to be in excellent health. In 2 cases minimal corneal changes, visible only on examination with the slit lamp, persisted for three weeks when 0.1 Gm. of quinacrine hydrochloride a day was taken. These changes finally disappeared three weeks after the drug had been discontinued and 0.6 Gm. of quinine a day substituted. A small therapeutic course of quinacrine given to each patient after all signs of epithelial edema with the slit lamp had disappeared resulted in a full blown recurrence in all 3. In each patient the visual disturbance was most severe when he was receiving more than the usual suppressive dose of quinacrine hydrochloride (0.1 Gm. per day). Reduction of the dose to the usual suppressive level did not suffice to clear up the condition entirely. This process is apparently reversible and does not result in permanent damage to the ocular tissues. J. A. M. A. (W. ZENTMAYER).

SURVEY OF THE TREATMENT OF TRAUMATIC CORNEAL ULCER. A. SMITH, Brit. J. Ophth. **30**:178 (March) 1946.

A study was made of 351 patients with corneal ulcer admitted to the Royal Hospital, Sheffield, for inpatient treatment. Of these, 89 had ulcers of spontaneous origin (at least they gave no history of trauma) and 262 had traumatic ulcers. The visual acuity four months or longer after discharge showed that 14.3 per cent had no useful vision (6/60 or less), 78.5 per cent had vision of 6/12 or better and 48.2 per cent had vision of 6/6 or better.

Significant aspects of treatment were (1) the notable drop in number of days in the hospital after the internal administration of sulfonamide drugs became a routine treatment and (2) the effectiveness of pyrexial therapy (Coley's fluid [a mixed bacterial vaccine from Streptococcus pyogenes, Streptococcus erysipelatis and Bacillus prodigiosus]) combined with simultaneous administration of sulfonamide compounds. The latter may largely account for the excellent visual results obtained, particularly in the cases of hypopyon. W. ZENTMAYER.

CORNEAL VASCULARIZATION IN CHRONIC DISEASE. P. A. GARDINER, Brit. J. Ophth. **30**:581 (Oct.) 1946.

The aim of this study is to analyze the manifestations of corneal vascularization in series of chronically ill persons and to discuss their significance. In no case was there a double pathologic process, and in every case the disease was sufficiently severe to warrant either admission to a hospital or invaliding from the service. One hundred and ninety-one service patients were examined with the slit lamp. From this survey the following conclusions were drawn: The frequency and degree of corneal vascularization increase with the severity of the disease. Corneal vascularization is more pronounced with rheumatoid arthritis and fibrosis and with duodenal ulceration than with the other gastrointestinal diseases, osteoarthritis and a miscellaneous group of diseases. There is more corneal vascularization among ill patients who complain of ocular symptoms than among those with no ocular symptoms. Lacrimation, grittiness in the eyes and conjunctival congestion accompany corneal vascularization more often than do other symptoms, though vascularization does occur without any symptoms. In surveys for comparative health, only healthy subjects should be examined if conclusions are to be drawn about their nutrition. The presence of corneal vascularization may prove to be of considerable value in the differential diagnosis of diseases with functional imitations. W. ZENTMAYER.

SATTLER'S VEIL. J. DALLOS, Brit. J. Ophth. **30**:607 (Oct.) 1946.

After discussing the requisites for properly fitting contact lenses, Dallos takes up the problem of the blur which develops only after several hours of wear. Patients who wear contact lenses for two hours or more (sometimes less) will, as a rule, experience a corneal haze similar to that accompanying a mild attack of glaucoma. The biomicroscope shows a faint epithelial edema attended with a slight bluish haze in daylight and colored haloes around lights in the dark. After removal of the lens, the condition clears in twenty to thirty minutes. To this

condition the term Sattler's veil is given. The veil is even and is macroscopically diffuse. As a rule it starts as a blur over the entire cornea, but in some cases it may begin in an odd sector somewhere in the periphery. In morbid cases vesicles may form. Secondary infection with permanent damage has occurred in cases in which the veil has been ignored. The cause of the veil is fully discussed. The fact that a loosely worn, comfortable contact lens allows a longer span of clarity, that with insensitive or hypesthetic corneas there is hardly any veiling and that increasing use makes for decreasing veiling, all point to the tension of the eyelids as playing an important role in pressing the lens so tightly onto the surface of the eye as to interfere seriously with some of its physiologic functions. The author has experimented with carefully adjusted lenses so as to keep up air circulation through one or more active perforations and yet remain in constant contact over the pupillary area. There has invariably been an absence of veiling in all cases in which the lenses are fitted on these lines. W. ZENTMAYER.

Experimental Pathology

THE ROLE OF LENS SUBSTANCE IN EXPERIMENTAL GONORRHEAL IRITIS. M. J. DRELL, M. BOHNHOFF and C. P. MILLER, Am. J. Ophth. **29:** 1263 (Oct.) 1946.

Drell, Bohnhoff and Miller report experiments on rabbits in which inoculation of gonococci into the anterior chamber with injury to the lens caused a moderately severe and chronic inflammation, but produced mild inflammation when there was no injury to the lens. Inoculation of a mixture of gonococci and lens substance usually caused a similar mild reaction. Lens substance in vitro, particularly after autolysis, prolonged the survival time of the gonococci. W. S. REESE.

General

OCCUPATIONAL EYE DISEASES. JOSEPH MINTON, Brit. M. J. **1:** 211 (Feb. 9) 1946.

In the diagnosis and treatment of injuries and diseases of the eye the author emphasizes the importance of investigating the nature of the patient's occupation. Many cases of acute and chronic conjunctivitis or keratitis owe their origin to occupational factors, just as obscure cases of retinitis, retrobulbar neuritis, ocular palsies and amblyopia should make one think of chronic poisoning arising from industrial solvents.

Among the causes of acute and chronic keratitis there is mentioned the injury from hydrogen sulfide, which is used in the artificial silk industry and in the sugar industry. Workers in furniture trades, metal industries and straw hat factories occasionally acquire keratitis from the use of benzene and similar solvents of varnishes and shellac. Agricultural workers suffer from exposure to various weeds and peat dust. Lenticular opacities were observed in 20 per cent of persons employed in a glass industry. These opacities were found to be due to infra-red rays and were situated in the posterior cortex of the lens. Similar changes were observed in furnace workers. The development is slow, and it frequently takes from ten to twenty years of work for these

opacities to develop. The most important of the industrial poisons are lead, derivatives of benzene, carbon bisulfide, methyl alcohol, arsenic and its derivatives, carbon tetrachloride and trichloroethylene. These substances cause toxic amblyopias, optic neuritis and ocular palsies.

In order to deal with these problems of occupational diseases and ocular injuries, the Royal Eye Hospital has established a department of industrial ophthalmology. The ophthalmologist in attendance has the advantage of the assistance of skilled engineers, safety officers and makers of preventive appliances to advise him on technical problems.

The largest number of cases referred to the department are those of corneal foreign bodies from grindstones. Ocular disturbances due to welding are described. The symptoms consist in photophobia and lacrimation; conjunctivitis and mild superficial keratitis were found to be present. The author recommends treatment with epinephrine hydrochloride (1:2,000), in drops, and phenacaine or tetracaine hydrochloride, 1 per cent, cold applications are advisable. A certain number of welders exhibited chronic superficial keratitis, with multiple erosions on the cornea, and complained of blurring of vision, a sense of grittiness and photophobia. Chronic conjunctivitis is often due to the patient's working in dusty workshops with insufficient ventilation.

The author concludes with the statement that the search for occupational causes in cases of ocular inflammation or injury is all-important. It is not sufficient to search for a septic focus, but the working conditions should be inquired into. In a department of industrial ophthalmology not only can the eye be properly treated, but the cause and prevention should be investigated.

ARNOLD KNAPP.

General Diseases

PERIARTERITIS NODOSA WITH INVOLVEMENT OF THE CHOROIDAL AND RETINAL ARTERIES. J. GOLDSMITH, Am. J. Ophth. **29**:435 (April) 1946.

Goldsmith reports a case of periarteritis nodosa with necropsy observations and claims that the diagnosis was first made during life by ophthalmoscopic observation in conjunction with the physical findings and the clinical course. The possibility of inducing hyperergic states within the human body by administration of sulfonamide drugs and serum is discussed.

W. S. REESE.

EARLY OCULAR MANIFESTATIONS IN THE LAURENCE-MOON-BIEDL SYNDROME. D. J. LYLE, Am. J. Ophth. **29**: 939 (Aug.) 1946.

Lyle reports 2 cases and describes the Laurence-Moon-Biedl syndrome. He notes that resemblance to hereditary optic atrophy (Leber's disease) and the various types of cerebromacular degeneration with central scotoma, loss of vision and cerebral symptoms is remarkable in the early stages of the two conditions. In the later stages the pigmentary degeneration may be confused with typical retinitis (retinosis) pigmentosa by the casual observer who fails to take a detailed history of the case and to make a complete examination in order to reveal the other components of the syndrome.

W. S. REESE.

INTRAOCULAR MANIFESTATIONS OF ACUTE DISSEMINATED LUPUS ERYTHEMATOSUS. F. L. P. KOCH and W. P. MCGUIRE, Am. J. Ophth. **29**:1243 (Oct.) 1946.

Koch and McGuire report a rather baffling case of a disorder diagnosed as acute disseminated lupus erythematosus in which marked retinal vascular disease was present and progressed up to the time of death.

W. S. REESE.

NUTRITIONAL AMBLYOPIA IN AMERICAN PRISONERS OF WAR LIBERATED FROM THE JAPANESE. S. M. BLOOM, E. H. MERZ and W. W. TAYLOR, Am. J. Ophth. **29**:1248 (Oct.) 1946.

Bloom, Merz and Taylor report early ophthalmic changes in American soldiers while in Japanese prison camps and residual changes in some of these men after liberation. They showed central or cecocentral scotoma with defective vision and pallor of the nerve heads, apparently due to lack of thiamine. If treatment is not instituted early enough, the condition becomes irreversible, as evidenced by lack of response to intensive vitamin therapy.

W. S. REESE.

IMPORTANCE OF THE HISTORY IN THE DIAGNOSIS OF OCULAR TUBERCULOSIS. JEAN FERRIE, Ophthalmologica **111**:332 (June) 1946.

Since it is usually impossible to perform a biopsy and the laboratory tests are generally unreliable, a diagnosis of ocular tuberculosis must be based primarily on the patient's history, the results of general examination and the reactions to the tuberculin and therapeutic tests. This article lays stress on the history of previous tuberculosis in both the patient and his family.

F. H. ADLER.

Glaucoma

GLAUCOMA PHACOGENETICUM, WITH ANATOMIC OBSERVATIONS: REPORT OF TWO CASES. W. P. C. ZEEMAN, Ophthalmologica **106**: 136 (Sept.) 1943.

Two cases are reported of hypermature cataract with subsequent acute inflammation and glaucoma. The eyes were removed and examined histologically. Numerous enlarged cells with orange-colored contents were observed in the angle of the anterior chamber after appropriate sudan staining. Similar cells were seen in the spaces of Fontana and in the stroma of the iris. The optic disk showed edema and a deposit of amorphous substances without any typical inflammatory infiltrates. The author believes that the inflammatory changes were due to a release of toxins from the disintegrating lens substance.

F. H. ADLER.

Injuries

MUSTARD-GAS BURNS OF HUMAN EYES IN WORLD WAR II. G. I. UHDE, Am. J. Ophth. **29**:929 (Aug.) 1946.

Uhde reports on 790 cases of mustard vapor (dichloroethyl sulfide) burns acquired accidentally at the Edgewood Arsenal. He presents a classification, with illustrative cases, and discusses the clinicopathologic observations.

W. S. REESE.

A Study of Lewisite Lesions of the Eyes of Rabbits. I. Mann, A. Pirie and B. D. Pullinger, Am. J. Ophth. **29:** 1215 (Oct.) 1946.

Mann, Pirie and Pullinger, in experiments on rabbits, found no condition similar to delayed mustard gas (dichloroethylsulfide) keratitis resulting from lewisite (betachlorovinyldichloroarsine). The eyes recovered, showed stable scars or were destroyed. The main points of interest were (1) peculiar effect on the corneal endothelium and corneal corpuscles; (2) miosis; (3) intense, but transient, edema of the lids and conjunctiva; (4) intense edema of the cornea, reaching a maximum after the swelling of the lids had subsided; (5) characteristic type of vascularization; (6) involvement of the iris and ciliary body, with mesodermal depigmentation and shrinking and with the displacement of ectodermal pigment, and (7) an apparently specific effect for the total dose entering the eye rather than for the anatomic site of the lesion.

W. S. Reese.

The Use of Contact Corneal Rings in X-Ray Localization of Intraocular Foreign Bodies. J. L. Reis, Brit. J. Ophth. **30:**462 (Aug.) 1946.

To Reis, the Sweet, the McGrigor or the Kraus and Briggs method of roentgenologic localization of intraocular foreign bodies seems to be the best, but each of these technics requires special apparatus. To avoid some of the objections to previously described contact methods, Reis employs thin metal rings exactly fitting the corneal margin. The rings are made of lead and tin alloy, about 0.1 mm. thick. Such rings give sufficiently distinct shadows on roentgenograms to enable one in the commonly known way (by making a diagram) to localize a foreign body from the relations shown by the posteroanterior and lateral roentgenographic exposures. The method of construction and application and their advantages are described in detail. The article is illustrated.

W. Zentmayer.

Instruments

Use of the Schiøtz Tonometer. H. Arruga, Arch. Soc. de oftal. hispano-am. **6:**85 (Jan.) 1946.

Arruga reports an ingenious method to facilitate the reading of the tonometer of Schiøtz without having to refer to the scale on the card. It consists in fixing in the two small pivots that limit the excursions of the needle and which hold the white celluloid plaque in which the graduations of the instrument are marked a piece of cardboard in which he has marked the amount of pressure in millimeters of mercury that corresponds to each of the lines in the celluloid plaque of the tonometer. A constant weight of 7.5 Gm. has to be used. As different tonometers have different scales, different cards have to be used for them. Illustrations of his device are shown.

H. F. Carrasquillo.

Lens

SPONTANEOUS RUPTURE OF THE LENS CAPSULE IN ANTERIOR LENTICONUS. L. H. EHRLICH, Am. J. Ophth. **29:** 1274 (Oct.) 1946.

Ehrlich reports the case of a 12 year old boy who first noted defective vision in the right eye three years before, following a mild blow in a fist fight. Vision in this eye was 4/200, and examination with the slit lamp revealed a bulging forward of the anterior capsule in the axial region. This elevation seemed filled with a clear fluid. A month later a tear was discovered at the summit of the bulge, and soft lens material protruded into the anterior chamber. During this time changes in the lens of the left eye made their appearance and at the end of a year assumed the form of a horseshoe. W. S. REESE.

CONTUSION CATARACT OF THE ANTERIOR LENS CAPSULE. H. F. SUDRANSKI, Am. J. Ophth. **29:** 1281 (Oct.) 1946.

Sudranski reports the case of a youth aged 20 who was struck in the right eye by a blast of compressed air. Roentgenologic examination revealed the presence of two metallic foreign bodies, and a healed perforating wound of the cornea and a hole in the iris were noted. Focal and biomicroscopic examinations showed a complete reproduction of the circular muscle fibers of the pupillary sphincter and of the radial pattern of the iris on the anterior capsule of the lens. W. S. REESE.

A NEW METHOD OF KERATOTOMY FOR USE IN THE CATARACT OPERATION. A. BUJADOUX, Arch. d'opht. **6:** 22, 1946.

The author emphasizes the necessity of an exactly placed and directed incision for the cataract operation. In this paper he presents a knife which makes the incision with a direct thrust across the anterior chamber. He insists that absolute immobilization of the eye is necessary and describes his method of accomplishing this. S. B. MARLOW.

LIGHT REFLEXES ASSOCIATED WITH SPHEROPHAKIA. A. E. SCHMID, Ophthalmologica **111:** 359 (June) 1946.

A case is reported of so-called dysmorphodystrophia mesodermalis congenita, a type described by Marchesani, in which there were a luxated spherŏphakic lens in the anterior chamber of one eye and a subluxated lens in the opposite eye. It is well known that the normal lens when dislocated into the anterior chamber shows under certain conditions of illumination an illuminated line around the entire equator, which is known as the gold edge, or *"gold Rand."* In the case of the spherophakic lens other reflex streaks besides this equatorial one appear. An illustration is given of these reflex streaks, and the author discusses the origin and nature of the light reflexes in spherophakia and microphakia. F. H. ADLER.

CONTUSION AND MASSAGE CATARACTS. A. E. SCHMID, Ophthalmologica **111:** 365 (June) 1946.

Under ordinary conditions, the movements of the iris on the surface of the lens, caused by changes in the size of the pupil, do not produce any loss of transparency of the lens. Movements of the lens itself against the iris, however, such as occur with a luxated lens in the anterior chamber, can cause such opacities. The author observed such opacities in a case of spherophakia described in a previous article. The origin of these opacities is discussed.

F. H. ADLER.

Neurology

BOWEN'S DISEASE OF THE CONJUNCTIVA. V. R. KHANOLKAR, Am. J. Ophth. **29:**515 (May) 1946.

Khanolkar observed a case of Bowen's disease of the conjunctiva for a period of eight and a half years and studied tissue removed on four different occasions; during this period the tumor changed from a relatively benign to a definitely malignant one. The treatment of choice is unfiltered radiation from a bare radium bulb.

W. S. REESE.

HYSTERICAL AMBLYOPIA. E. R. YASUNA, Am. J. Ophth. **29:** 570 (May) 1946.

Yasuna observed 15 cases of hysterical amblyopia at the Fort Snelling separation center. He found the distance discrepancy in the peripheral fields the most important aid in diagnosis. He states that disability ratings should be based on the severity of the hysteria and not on the amount of visual or field loss.

W. S. REESE.

THE EYE EXAMINATION IN THE DIFFERENTIAL DIAGNOSIS OF THE DISORIENTED PATIENT. B. MILDER, Am. J. Ophth. **29:**953 (Aug.) 1946.

Milder found ophthalmic examinations of the greatest significance in the early diagnosis of psychotic and comatose states resulting from brain tumor and cerebrovascular disease, especially hypertensive encephalopathy and cerebrovascular accidents. Of less value were the ocular findings in diagnosis of uremic coma and syphilis of the central nervous system.

W. S. REESE.

Ocular Muscles

A CONTINUATION OF THE SCREEN TEST. H. G. MARTIN, Am. J. Ophth. **29:** 196 (Feb.) 1946.

Martin offers a method as a continuation of the usually performed screen test which aids in defining the offending mechanism in conditions of variation from accepted normal balance. Used with other muscle tests for near vision, these tests afford information regarding the values of the most important contributors in the combined function of vergence. The objective nature of these tests permits their use on uncooperative and very young patients.

W. S. REESE.

THE SURGICAL TREATMENT OF STRABISMUS. D. B. KIRBY, Am. J. Ophth. **29:** 408 (April) 1946.

Kirby feels that operation may well be performed at an early age if strabismus is not corrected by orthoptic measures and that operation may be planned beforehand, but the actual details and extent of the procedure may not be evident until the muscles are exposed. It is better to do too little than too much and if further surgical intervention is necessary to wait until the tissues have healed and resolved. He urges proper care and orthoptic training after operation. W. S. REESE.

Operations

METHACRYLIC RESIN IMPLANT FOR SUNKEN UPPER LID FOLLOWING ENUCLEATION. H. S. SUGAR and H. J. FORESTNER, Am. J. Ophth. **29:** 993 (Aug.) 1946.

Sugar and Forestner describe a method of implanting a methylmethacrylate implant into the upper lid to obviate the sinking sometimes seen after enucleation. W. S. REESE.

Orbit, Eyeball and Accessory Sinuses

DECOMPRESSION OF ORBIT. J. S. GUYTON, Surgery **19:** 790 (June) 1946.

Guyton advises decompression of the orbit for the reduction of severe exophthalmos, in which there is an increase in the weight of all orbital structures (muscles, fat, lacrimal glands) due to increased water storage, with progressive hypertrophy and degeneration of the extraocular muscles, scattered lymphocytic infiltration and progressive fibrosis of the orbital structures. Incomplete closure of the lids and impaired nutrition may cause corneal ulceration. The increase in retrobulbar pressure may be great enough to cause papilledema and secondary atrophy of the optic nerve. Loss of vision has been reported in scores of cases. The orbit can be decompressed into the anterior cranial fossa, the frontal and ethmoid sinuses or the temporal fossa. The author describes an improved technic utilizing the temporal fossa. This operation is the least dangerous of the various decompressions, being extracranial, performed in an aseptic field and not endangering any important structures. It leaves no visible scar or other cosmetic defect and gives a completely adequate decompression. Its use is recommended for patients desiring cosmetic improvement of exophthalmic disfigurement as well as for those with threatened impairment of visual function. J. A. M. A. (W. ZENTMAYER).

REPORT ON A CASE OF HYDROPHTHALMIA (BUPHTHALMOS). E. EPSTEIN, Brit. J. Ophth. **30:** 476 (Aug.) 1946.

The case described had many features which might have suggested the diagnosis of megalocornea but proved to be one of hydrophthalmos. It indicates that the diagnosis of megalocornea in the absence of a familial history can be most difficult and should then be made reservedly. W. ZENTMAYER.

Parasites

NOTES ON ONCHOCERCIASIS IN GUATEMALA. R. PACHECO-LUNA, Brit. J. Ophth. **30**:234 (April) 1946.

Onchocerciasis (filariasis) or onchocercosis, also known as Roble's disease, or blinding disease of Guatemala, is a new nosologic entity, caused by a parasite which profoundly affects the visual organ in a great number of cases. It is estimated that 20,000 persons in Guatemala are infected with onchocerciasis. Ocular manifestations are observed in 30 per cent of these patients, and 2 per cent are blind. At first the biomicroscope shows tenuous superficial punctate keratitis, consisting of avascular punctiform infiltrations. Iritis may be present independently or may accompany the keratitis. The process usually extends to the uveal tract, and degenerated pigmentary lesions of the choroid and retina with no relation to the vessels develop; and the process may end in phthisis of the eye. No therapeutic agent has been found which acts with good results on the parasites.

W. ZENTMAYER.

Pharmacology

CONCENTRATION OF PENICILLIN IN THE AQUEOUS HUMOR FOLLOWING SYSTEMIC ADMINISTRATION. A. E. TOWN and M. E. HUNT, Am. J. Ophth. **29**: 171 (Feb.) 1946.

Town and Hunt found penicillin present in the aqueous at a lower level than that of the blood after systemic administration. After paracentesis, however, the aqueous is reformed in forty minutes, with a concentration approximating that of the blood serum.

W. S. REESE.

Refraction and Accommodation

CORRESPONDING AND OBLIQUE MOVEMENTS IN RETINOSCOPY. J. I. PASCAL, Eye, Ear, Nose & Throat Monthly **25**: 148 (March) 1946.

Corresponding movements are movements in the same plane as the mirror movements. Oblique movements run along a meridian different from that of the mirror movements. The presence of astigmatism is noted at once when on the initial mirror movements the reflex movements are "oblique." The principal purpose of noticing the oblique movements is for the determination of the correct axis of astigmatism when present. Observations of oblique movements are important in cylinder retinoscopy.

A. COWAN.

Retina and Optic Nerve

EFFECT OF ANTEPARTUM VITAMIN K ON RETINAL HEMORRHAGE. H. F. FALLS and H. N. JUROW, J. A. M. A. **131**: 203 (May 18) 1946.

The observations were made on 432 patients. Of the 151 patients who received antepartum treatment with vitamin K, 47, or 31.1 per cent of the newborn had retinal hemorrhages, and of the 281 who did not receive vitamin K ante partum, 94, or 32.4 per cent, had retinal

hemorrhages. A difference of 1.3 per cent in the incidence of retinal hemorrhages in the two groups can hardly be called significant as to the effectiveness of vitamin K. The following conclusions are reached.

Vitamin K administered either ante partum or intra partum does not reduce the incidence of retinal hemorrhages in the newborn.

Vitamin K thus administered raises the infant prothrombin time during the physiologic decline. J. A. M. A. (W. ZENTMAYER).

THE DIAGNOSTIC AND CLINICAL VALUE OF SOME FORMS OF RETINAL ANGIOSPASM. N. PINES, Brit. J. Ophth. **30:** 470 (Aug.) 1946.

Pines tries to establish a connection between the ophthalmoscopic picture of the retina and the result of the general clinical examination, especially that of the arterial circulation. After describing the normal narrowing of the arteries from the surface of the disk to the periphery, the author states that in many healthy young men, usually those below 30 years of age, in spite of absence of translucency of the retinal vessels, this gradual diminution of the arterial lumen is present, but in persons of early middle age it is quite the reverse. If the artery is followed from a point near the disk, a tiny bit of it becomes slightly narrower, say to one-tenth its volume, and immediately after that it becomes wider again and then gradually narrows until it disappears altogether. It may affect tiny bits, up to 1/20 disk diameter, in the primary and secondary branches. This physiologic angiospasm of retinal arteries is part of a general one; i.e., the retina is subject to the influence of the general vasomotor center. The symptom by itself is only the first step in the accommodation of the body to a new condition of vascular life. The clue to the diagnosis are the sphygmomanometric, dynamometric (for the retina) and oscillometric readings, together with the general clinical picture. W. ZENTMAYER.

Trachoma

NECESSITY OF AN INTERNATIONAL STUDY CENTRE OF TRACHOMA. L. POLEFF, Brit. J. Ophth. **30:** 287 (May) 1946.

Poleff makes a plea for an international trachomatologic institute. He is of the opinion that Morocco would be the most convenient place for its establishment, a trachoma country *par excellence,* situated between the ancient and the new continents. W. ZENTMAYER.

Book Reviews

Tabulae pseudo-isochromaticae B.-K.: Plates for testing colour vision. By C. G. Boström and I. Kugelberg. Price, 35.7 crowns. Pp. 3. Stockholm, Sweden: Kifa, 1943.

This is a new series of pseudoisochromatic plates for testing red-green vision published in 1943 and only recently reaching this country. It was designed by C. G. Boström, ophthalmic adviser to the Board of Swedish Railways, and I. Kugelberg, docent in ophthalmology at the Karolinska Institute, Stockholm, Sweden. The Swedish medical board has officially prescribed the use of this test for examinations of the color sense for traffic and transport service. (In preparing this review, I have taken the liberty of including information received in a personal communication from the publisher of the test.)

The series consists of 20 plates of uniform size, mounted so that their serial order permits variation. There are 15 plates with one numeral, 2 plates with a serpentine line and three dissimulation plates without design. All plates have the same outline pattern, which is filled with the same mosaic of round dots, 2.5 mm. in diameter, arranged in staggered horizontal rows. In the significant plates some of the dots are colored in one hue to form a design on the background dots, which are colored in a different hue. In all, fifteen paired colors are thus presented, planned, as stated by the publisher, to cover the confusion color pairs of practically all forms of defective red-green vision. Three value levels are presented in the dots of both figure and ground, and all colors are of low chroma. Information is not given as to the basis on which the confusion pairs were selected, and no differential classification of the extent or the type of defect revealed by the various plates is claimed. The test is intended for screening purposes only.

A three page leaflet of directions for administering the test is supplied. "The examination shall be carried out, if possible, in full daylight. If urgently required, as for instance during the darkest months of the year, the test may be performed in the light of a really good, so-called daylight lamp." The observation distance is 50 to 75 mm.; the time of exposition of each plate is not to exceed fifteen seconds, during which time the testee is permitted to outline the design if he hesitates to name it. Normal color sense is indicated by the successful reading or outlining of the figure or path in 17 plates and the failure to see any design on the dissimulation plates; failure to read 2 or more significant plates indicates defective color vision; failure to read only 1 plate indicates doubtful color vision, which calls for more detailed examination by other technics.

If a more exact specification of the amount and quality of the illumination under which the plates are to be administered had been made, the B.-K. series might have provided an interesting addition to the growing list of pseudoisochromatic tests. Because of the small size of the colored dots and their low chroma, this series appears on inspec-

tion to be a more rigid and sensitive test of color performance than are the series of Stilling, Ishihara and Rabkin and the plates compiled by the American Optical Company. It is probable that for many subjects who have been classified as having low normal color vision a diagnosis of defective color vision would have been made with the new Swedish plates. Particularly because of the higher sensitivity of the test, however, a more exact specification of the illuminant to be used should unquestionably have been made. The spectral composition of "full daylight" varies within wide limits, and any test which employs pigment stimuli is valid only when the color temperature of the illuminant for which it was designed is exactly specified and followed during the administration. Standard illuminants for color work were adopted in 1931 by the International Commission on Illumination, and today this type of specification is accepted as mandatory for the accurate testing of color vision with pigment stimuli.

GERTRUDE RAND.

Diseases of the Retina. By Herman Elwyn, M.D. Price, $10. Pp. 587 with 170 illustrations, 19 in color. Philadelphia: The Blakiston Company (Division of Doubleday & Company, Inc.), 1946.

During the past decade a most serious shortage in texts and monographs in the many special subdivisions of the general field of ophthalmology has developed in this country. This shortage has now become so severe that it is practically impossible for a young ophthalmologist to obtain an adequate work shelf of reference books. Part of the difficulty is attributable to the habit of dependence acquired long ago on the supply of such texts and monographs from European publishers. There has been no dearth of able and ambitious authors, but American publishers have been reluctant to undertake what was very likely to prove a losing venture. Some 150 new ophthalmologists are born into the profession in this country each year. Since books cannot be produced in editions of less than one to two thousand without excessive cost per copy, even the most successful text cannot be sold out in less than ten to fifteen years, and by that time progress in knowledge often demands considerable rewriting. Thus, the expectation of profit from reprinting is almost completely absent. Consequently the commercial publisher could hardly be expected to push this field unless he was prepared to compete for the international market.

Against this doleful background, the publication of Dr. Elwyn's excellent book on diseases of the retina is a potential harbinger of spring. Dr. Elwyn has already established himself as a competent and successful author by his book on nephritis, and he brings to his subject the rare combination of a thorough training in both ophthalmology and internal medicine. The book contains several novel and useful features of organization, such as the grouping together in one section the "diseases of the retina leading to retinal detachment," and has achieved an unusual compactness and coherence as the result of these innovations. It contains an unusually solid amount of histopathologic data, furnishing in their way an excellent foundation for the clinical evaluations. References to the modern literature have been chosen with much care,

affording the reader a well balanced approach to original articles, while avoiding the burdensome pedantry of an attempt at completeness which has, in the past, characterized many Continental texts. The illustrations, especially the drawings of the fundus, most of which have been reproduced from publications in the current literature, reflect the general improvement in this field during the past generation.

J. S. FRIEDENWALD.

Les aspects pathologiques du fond de l'oeil dans les affections de la rétine (atlas ophthalmoscopique). By Gabriel Renard. Pp. 172, with 32 plates in colors. Paris: Masson & Cie, 1946.

This is a continuation of the monographs on the ophthalmoscopic examination of the fundus oculi, which began with Professor Danis' excellent report on the "Normal Appearance and the Congenital Anomalies of the Eyeground," was published in 1940 and reviewed in the ARCHIVES (**24:** 855 [Oct.] 1940). Notwithstanding the difficulties of bringing out a satisfactory volume in the trying years that have just passed, the obstacles have been overcome, and this report was presented at the congress of the French Society of Ophthalmology in May 1946.

This volume brings pictures of various aspects of retinal contusion; two conditions peculiar to children, namely, glioma and hemorrhagic pachymeningitis; the macular hemorrhages associated with myopia, folds of the retina and angioid striae, Coats's retinitis and phakomatoses; familial degenerations; indefinite and senile macular changes, and, finally, isolated lesions of the retinal vessels, arterial obliteration, venous thrombosis and hemorrhages in the vitreous. The book aims at a complete illustration of a few diseases of the retina and is chiefly a clinical treatise. Treatment is omitted. Pathology is described only if it clarifies the clinical condition. There are 32 plates, with 60 pictures in color; comments are added to each observation, and there is a bibliography of 260 articles which should be of interest to the ophthalmologist. The colored drawings are excellent and are the work of Mlle. Lalau.

While the list includes only a few of the lesions of the fundus, those portrayed are well selected and instructive. It is stated that additional drawings will appear in a future volume.

The author and the French Society of Ophthalmology are to be congratulated on the resumption of the publication of this interesting and important series, and it is to be hoped that future numbers will appear without interruption.

ARNOLD KNAPP.

Eye Health: A Teaching Handbook for Nurses. By Anna C. Gring, R.N., and Eleanor W. Mumford, R.N. Price, $0.60. Pp. 108. New York: The National Society for the Prevention of Blindness, Inc., 1946.

The National Society for the Prevention of Blindness, Inc., has brought out a small handbook of 108 pages for nurses who deal with eye health. Simple discussions of the following topics are given: anatomy and physiology of the eye, refraction and motor anomalies,

principles of lighting, simple examinations implied in the term "screening," causes of defective vision, the eyes in childhood and in adult life, and first aid care and treatment of injuries to the eyes.

One cannot but feel that this is a rather formidable list of subjects for a small handbook and that the superficial knowledge conveyed will hardly fit the nurse to answer questions for which training in medicine and in ophthalmology is required.

1946 Year Book of Eye, Ear, Nose and Throat. By Louis Bothman, M.D., and Samuel J. Crowe, M.D. Price, $3.75. Pp. 543. Chicago: Year Book Publishers, Inc., 1946.

In the 1946 Year Book of the Eye, Ear, Nose and Throat, Dr. Louis Bothman, editor of the section on the eye, brings a special article on the medical treatment of glaucoma. A plea is made for the medical treatment of glaucoma, with the statement that the tension in many cases can be controlled with miotics, without serious loss of vision or fields, and that carcholin (an ophthalmic preparation of carbaminoylcholine chloride) is found to be a most satisfactory drug for the treatment of glaucoma. A complete survey then follows of the articles that have appeared in the ophthalmologic literature during the previous year, arranged according to the usual anatomic classification. Many of the articles are illustrated, and the editor has often added interesting and valuable comments from his own experience. Chapters on injuries and on surgical procedures are added, and under the title "General and Miscellaneous" the reader will find abstracts on general topics, such as vascular spasm, detergents, penetration of penicillin, dietary deficiency, alkali treatment of methyl alcohol poisoning, ocular intoxication by so-called green tobacco, use of antistin (an imidazole derivative) in ophthalmology, treatment of ocular syphilis with hyperpyrexia and malaria, tropical diseases, Reiter's disease, ocular leprosy, Behcet's disease and temporal arteritis.

This excellent treatise fulfils a definite want. The subjects are well covered, and the abstracting is well done. Dr. Bothman deserves great credit for an interesting and valuable book, which can be confidently recommended.

ARNOLD KNAPP.

Directory of Ophthalmologic Societies *

INTERNATIONAL

International Association for Prevention of Blindness

President: Dr. P. Bailliart, 66 Boulevard Saint-Michel, Paris, 6e, France.
Secretary-General: Dr. A. Churchill, 66 Boulevard Saint-Michel, Paris, 6e, France.
All correspondence should be addressed to the Secretariat, 66 Boulevard Saint-Michel, Paris, 6e, France.

International Council of Ophthalmology

President: Prof. F. W. Nordenson, 3 Grefgatan, Stockholm, Sweden.
Secretary: Dr. Holger Ehlers, 4 Fernbanegade, Copenhagen, Denmark.

International Organization Against Trachoma

President: Dr. A. F. MacCallan, 17 Horseferry Rd., London S. W., England.

Pan-American Association of Ophthalmology

President: Dr. Harry S. Gradle, 14060 Valley Vista Blvd., Sherman Oaks, Calif.
Executive Secretaries: Dr. Conrad Berens, 301 E. 14th St., New York 3. Dr. M. E. Alvaro, 1151 Rua Consolacão, São Paulo, Brazil.
Place: Habana, Cuba. Time: Jan. 10, 1948.

FOREIGN

All-India Ophthalmological Society

President: Dr. E. V. Srinivasan, Mylapore, Madras.
Secretary: Dr. G. Zachariah, 16 Marshall's Rd., Egmore, Madras.

Belgian Ophthalmologic Society

President: Dr. L. Weekers, rue Forgeur 15, Liége.
Secretary-General: Dr. M. Appelmans, Avenue Ruelens 179, Louvain.

British Medical Association, Section on Ophthalmology

President: Dr. W. Clark Souter, 9 Albyn Pl., Aberdeen, Scotland.
Secretary: Dr. Frederick Ridley, 12 Wimpole St., London, W. 1.

Chengtu Ophthalmological Society

President: Dr. Eugene Chan.
Secretary: Dr. D. S. Shen, Eye, Ear, Nose and Throat Hospital, Chengtu, Szechuan, China.
Place: Eye, Ear, Nose and Throat Hospital, Chengtu, Szechuan, China.

Chinese Ophthalmology Society

President: Dr. C. H. Chou, 363 Avenue Haig, Shanghai.
Secretary: Dr. F. S. Tsang, 221 Foochow Rd. Shanghai.

Chinese Ophthalmological Society of Peiping

President: Dr. H. T. Pi, Peiping Union Medical College, Peiping.
Secretary: Dr. C. K. Lin, 180 Hsi-Lo-yen Chienmeng, Peiping.
Place: Peiping Union Medical College, Peiping. Time: Last Friday of each month.

* Secretaries of societies are requested to furnish the information necessary to make this list complete and keep it up to date.

Faculty of Ophthalmologists

President: Sir Stewart Duke-Elder, 63 Harley St., London, W. 1, England.
Secretary: Mr. Frank W. Law, 45 Lincoln's Inn Fields, London, W. C. 2, England.

German Ophthalmological Society

President: Prof. W. Lohlein, Berlin.
Secretary: Prof. E. Engelking, Heidelberg.

Hungarian Ophthalmological Society

President: Prof. I. Imre, Budapest.
Assistant Secretary: Dr. Stephen de Grósz, University Eye Hospital, Máriautca 39, Budapest.
All correspondence should be addressed to the Assistant Secretary.

Midland Ophthalmological Society

President: Mr. Charles Rudd, 91 Cornwall St., Birmingham 3, England.
Secretary: Mr. P. Sameson Evans, 51 Calthorpe Rd., Birmingham 3, England.
Place: Birmingham and Midland Eye Hospital.

North of England Ophthalmological Society

President: Mr. O. M. Duthie, 22 St. John St., Manchester.
Secretary: Mr. William M. Muirhead, 70 Upper Hanover St., Sheffield 3.
Place: Manchester, Leeds, Newcastle-upon-Tyne, Liverpool, Sheffield and Bradford, in rotation. Time: October to May.

Ophthalmological Society of Australia

President: Dr. J. Ringland Anderson, Astor House, 108 Collins St., Melbourne, Victoria.
Secretary: Dr. D. A. Williams, 27 Commonwealth St., Sydney.
Time: Sept. 23-26, 1947.

Ophthalmological Society of Egypt

President: Prof. Dr. Mahmoud Lutfi, Ophthalmic Hospital, Giza.
Secretary: Dr. Mohammed Abbas El Bakly, Ministry of Public Health, Cairo.
All correspondence should be addressed to the secretary, Dr. Mohammed Khalil.

Ophthalmological Society of Hospital de Nuestra Señora de la Luz

Chairman: Dr. Manuel J. Icaza y Dublán, Artes 72, México, D. F., Mexico.
Secretary: Dr. Jorge Meyrán, Ezequiel Montes 135, México, D. F., Mexico.
Place: Hospital de Nuestras Señora de la Luz. Time: Second Friday of each month.

Ophthalmological Society of New Zealand

President: Mr. W. A. Fairclough, Imperial Bldgs., Queen St., Auckland.
Secretary: Dr. W. J. Hope-Robertson, Kelvin Chambers, 16 The Terrace, Wellington.

Ophthalmological Society of South Africa

President: Dr. A. Verwey, Phoenix Chambers, Church St., Pietermaritzburg.
Secretary: Dr. J. K. de Kock, Groote Kerk Bldg., 32 Parliament St., Cape Town.

Ophthalmological Society of the United Kingdom

President: Dr. A. J. Ballantyne, 11 Sandyford Pl., W., Glasgow C. 3, Scotland.
Secretary: Mr. J. H. Doggart, 49 Wimpole St., London, W. 1.

Ophthalmology Society of Bombay

President: Dr. D. D. Sathaye, 127 Girgaum Rd., Bombay 4, India.
Secretary: Dr. H. D. Dastur, Dadar, Bombay 14, India.
Place: H. B. A. Free Ophthalmic Hospital, Parel, Bombay 12. Time: First Friday of every month.

Oxford Ophthalmological Congress

Master: Mr. F. A. Williamson-Noble, 27 Harley St., London W. 1, England.
Secretary-Treasurer: Dr. F. A. Anderson, 12 St. John's Hill, Shrewsbury, England.
Place: Oxford. Time: July 3-5, 1947.

Palestine Ophthalmological Society

President: Dr. Arieh Feigenbaum, Abyssinian St. 15, Jerusalem.
Secretary: Dr. E. Sinai, Tel Aviv.

Philippine Ophthalmological and Otolaryngological Society

President: Dr. Antonio S. Fernando, Philippine General Hospital, Manila.
Secretary-Treasurer: Dr. José N. Cruz, Philippine General Hospital, Manila.

Polish Ophthalmological Society

President: Dr. W. Kapuściński, Libelta 14, Poznań.
Secretary: Dr. S. Topolski, Piusa 38, Warsaw.
Place: Ophthalmic Clinic, Oczki 6, Warsaw. Time: Every two years—Summer.

Puerto Rico Medical Association, Section of Ophthalmology and Otolaryngology

President: Dr. José T. Picó, P. O. Box 3866, Santurce.
Secretary: Dr. Ricardo F. Fernández, Instituto Oftalmico, San Juan.
Place: Asociation Medica de Puerto Rico, Santuce.

Royal Society of Medicine, Section of Ophthalmology

President: Dr. Harold Levy, 149 Harley St., London, W. 1, England.
Secretaries: Dr. P. M. Moffatt, 115A Harley St., London, W. 1, England. Dr. A. S. Philps, 104 Hartley St., London W. 1, England.

São Paulo Society of Ophthalmology

President: Dr. Armando Gallo, Rua Benjamin Constant, 67, 9° Andar São Paulo, Brazil.
Secretary: Dr. F. Amédée Féret Filho, Rua Marconi, 48, 4° Andar, São Paulo. Brazil.

Scottish Ophthalmological Club

President: Dr. H. M. Traquair, 16 Manor Pl., Edinburgh 3.
Secretary: Dr. Alexander Garrow, 15 Woodside Pl., Glasgow, C. 3.
Place: Edinburgh and Glasgow, in rotation.

Sociedad Argentina de Oftalmologia

Chairman: Dr. Jorge Malbrán, Buenos Aires.
Secretary: Dr. Benito Just Tiscornia, Santa Fe 1171, Buenos Aires.

Sociedade Brasileira de Oftalmologia

President: Dr. Edilberto Campos, Rua Rodrigo Silva 7-1°, Rio de Janeiro, Brazil.
Secretary: Dr. Evaldo Campos, R. Rodrigo Silva 7-1° andar, Rio de Janeiro, Brazil.
Place: Rio de Janeiro, Brazil. Time: Third Friday of every month from April to December.

Sociedad Cubana de Oftalmologia

President: Prof. Lorenzo Comas, Calle D #461, Vedado, Habana, Cuba.
Secretary: Dr. Oscar F. Horstmann, Calle 5ta. #702, Vedado, Habana, Cuba.
Time: Second Tuesday of every month.

Sociedad Mexicana de Oftalmologia

President: Dr. Feliciano Palomino Dena, Londres 44, Mexico, D. F.
Secretary: Dr. Teodulo Agundis Jr., Lucerna 63, Mexico, D. F.
Place: Escuela Nacional de Medicina, Venezuela 4, Mexico, D. F. Time: 8:30 p. m., first Tuesday of each month.

Sociedad Oftalmologia del Litoral, Rosario (Argentina)

President: Prof. Dr. Enrique V. Bertolto, Rosario.
Secretary: Dr. Juan Manuel Vila Ortiz, Rosario.
Place: Rosario. Time: Last Saturday of every month, April to November. All correspondence should be addressed to the President.

Sociedade de Oftalmología del Norte

President: Dr. Alberto Cárdenas.
Secretary: Dr. Jorge Luis Castillo, Mendoza 421, Tucumán, Argentina.

Sociedade de Oftalmologia de Minas Geraes

President: Prof. Hilton Rocha, Rua Rio de Janeiro 2251, Bello Horizonte, Minas Geraes, Brazil.
Secretary: Dr. Ennio Coscarelli, Rua Aimorés 1697, Bello Horizonte, Minas Geraes, Brazil.

Sociedade de Oftalmologia e Otorinolaringologia do Rio Grande do Sul

President: Dr. Luiz Assumpção Osorio, Edificio Vera Cruz, Apartamento 134, Porto Alegre, Rio Grande do Sul.
Secretary: Dr. Fernando Voges Alves, Caixa Postal 928, Porto Alegre, Rio Grande do Sul.

Sociedade de Oftalmologia e Oto-Rhino-Laryngologia do Bahia

President: Dr. Theonilo Amorim, Barra Avenida, Bahia, Brazil.
Secretary: Dr. Adroaldo de Alencar, Brazil.
All correspondence should be addressed to the President.

Società Oftalmologica Italiana

President: Prof. Dott. Giuseppe Ovio, Ophthalmological Clinic, University of Rome, Rome.
Secretary: Prof. Dott. Epimaco Leonardi, Via del Gianicolo, 1, Rome.

Société Française d'Ophtalmologie

Secretary: Dr. René Onfray, 6 Avenue de la Motte Picquet, Paris, 7e.

Society of Swedish Ophthalmologists

President: Prof. S. Larsson, Lund, Sweden.
Secretary: Dr. K. O. Granström, Söderma!mstorg 4, Stockho!m Sö.

Southern Ophthalmological Society, England

President: Mr. J. E. H. Cogan, Tunbridge Wells, England.
Secretary: Mr. Nigel Cridland, 25 Craneswater Pk., Southsea, England.
Time: From March to October.

Tel Aviv Ophthalmological Society

President: Dr. D. Arieh-Friedman, 96 Allenby St., Tel Aviv, Palestine.
Secretary: Dr. Sadger Max, 9 Bialik St., Tel Aviv, Palestine.

NATIONAL

American Medical Association, Scientific Assembly, Section on Ophthalmology

Chairman: Dr. Everett L. Goar, 1300 Walker Ave., Houston, Texas.
Secretary: Dr. Trygve Gundersen, 101 Bay State Rd., Boston.
Place: Chicago. Time: June 21-25, 1948.

American Academy of Ophthalmology and Otolaryngology, Section on Ophthalmology

President: Dr. Alan C. Woods, Johns Hopkins Hospital, Baltimore 5.
President-Elect: Dr. C. H. McCaskey, 20 N. Meridian St., Indianapolis, Ind.
Executive Secretary-Treasurer: Dr. William L. Benedict, 100-1st Ave. Bldg., Rochester, Minn.
Place: Palmer House, Chicago. Time: Oct. 12-17, 1947.

American Ophthalmological Society

President: Dr. John W. Burke, 1740 M St. N. W., Washington, D. C.
Secretary-Treasurer: Dr. Walter S. Atkinson, 129 Clinton St., Watertown, N. Y.

Association for Research in Ophthalmology, Inc.

Chairman: Dr. Derrick Vail, 55 E. Washington St., Chicago 2.
Secretary-Treasurer: Dr. Brittain F. Payne, 17 E. 72d St., New York 2.
Assistant Secretary-Treasurer: Dr. Hunter Romain, 111 E. 65th St., New York.

Canadian Medical Association, Section on Ophthalmology

President: Dr. Alexander E. MacDonald, 170 St. George St., Toronto 5.
Secretary-Treasurer: Dr. L. J. Sebert, 170 St. George St., Toronto 5.

Canadian Ophthalmological Society

President: Dr. R. J. P. McCulloch, 830 Medical Arts Bldg., Toronto 5.
Secretary-Treasurer: Dr. J. F. A. Johnston, 174 St. George St., Toronto 5.

National Society for the Prevention of Blindness

President: Mr. Mason H. Bigelow, 1790 Broadway, New York 19.
Secretary: Miss Regina E. Schneider, 1790 Broadway, New York 19.
Executive Director: Mrs. Eleanor Brown Merrill, 1790 Broadway, New York.

SECTIONAL

Academy of Medicine of Northern New Jersey, Section on Eye, Ear, Nose and Throat

President: Dr. Anthony Ambrose, 31 Lincoln Park, Newark.
Secretary: Dr. W. Franklin Kein, 15 Washington St., Newark 2.
Place: 91 Lincoln Park South, Newark. Time: 8:45 p. m., second Monday of each month, October to May.

Central Illinois Society of Ophthalmology and Otolaryngology

President: Dr. Walter Stevenson, 510 Maine St., Quincy, Ill.
Secretary-Treasurer: Dr. William F. Hubble, 877 Citizens Bldg., Decatur, Ill.

Central Wisconsin Society of Ophthalmology and Otolaryngology

President: Dr. W. S. Jones, 521 Sheridan Rd., Menominee, Mich.
Secretary: Dr. G. L. McCormick, 650 S. Central Ave., Marshfield.

Hawaii Eye, Ear, Nose and Throat Society

President: Dr. Howard E. Crawford, P. O. Box 1962, Hilo.
Secretary-Treasurer: Dr. Tadao Hata, 1704 S. King St., Honolulu.
Place: Pacific Club, Honolulu. Time: Third Thursday of each month.

New England Ophthalmological Society

President: Dr. Edwin B. Dunphy, 243 Charles St., Boston.
Secretary-Treasurer: Dr. Merrill J. King, 264 Beacon St., Boston 16.
Place: Massachusetts Eye and Ear Infirmary, 243 Charles St., Boston. Time: 8 p. m., third Tuesday of each month from November to April, inclusive.

Pacific Coast Oto-Ophthalmological Society

President: Dr. D. H. O'Rourke, 1612 Tremont Pl., Denver.
Secretary-Treasurer: Dr. C. Allen Dickey, 450 Sutter St., San Francisco.

Puget Sound Academy of Ophthalmology and Oto-Laryngology

President: Dr. Walter C. Cameron, 1103 Medical Arts Bldg., Tacoma, Wash.
Secretary-Treasurer: Dr. Barton E. Peden, 301 Stimson Bldg., Seattle 1, Wash.
Place: Seattle or Tacoma, Wash. Time: Second Tuesday of each month except June, July and August.

Rock River Valley Eye, Ear, Nose and Throat Society

President: Dr. Robert C. Finger, RFD New Tower, Rockford, Ill.
Secretary-Treasurer: Dr. Vernon C. Voltz, 625 Gas-Electric Bldg., Rockford, Ill.
Place: Rockford, Ill., or Janesville or Beloit, Wis. Time: Third Tuesday of each month from October to April, inclusive.

Saginaw Valley Academy of Ophthalmology and Otolaryngology

President: Dr. Harold H. Heuser, 207 Davidson Bldg., Bay City, Mich.
Secretary-Treasurer: Dr. V. E. Cortopassi, 324 S. Washington Ave., Saginaw, Mich.
Place: Saginaw or Bay City, Mich. Time: Second Tuesday of each month, except July, August and September.

Sioux Valley Eye and Ear Academy

President: Dr. J. C. Decker, 515 Francis Bldg., Sioux City, Iowa.
Secretary-Treasurer: Dr. J. E. Dvorak, 408 Davidson Bldg., Sioux City, Iowa.

Southern Medical Association, Section on Ophthalmology and Otolaryngology

Chairman: Dr. Calhoun McDougall, Atlanta, Ga.
Secretary: Dr. Alston Callahan, 908 S. 20th St., Birmingham 5, Ala.
Time: First week in November.

Southwestern Academy of Eye, Ear, Nose and Throat

President: Dr. H. L. Brehmer, 221 W. Central Ave., Albuquerque, N. Mex.
Secretary: Dr. A. E. Cruthirds, 1011 Professional Bldg., Phoenix, Ariz.

Southwestern Michigan Triological Society

President: Dr. W. M. Dodge, 716 First National Bank Bldg., Battle Creek.
Secretary-Treasurer: D. Kenneth Lowe, 25 W. Michigan Ave., Battle Creek.
Time: Last Thursday of September, October, November, March, April and May.

Western Pennsylvania Eye, Ear, Nose and Throat Society

President: Dr. J. Paul McCloskey, 338 Locust St., Johnstown.
Secretary-Treasurer: Dr. Fred E. Murdock, 28½ W. Scribner St., Dubois.

STATE

Arkansas State Medical Society, Eye, Ear, Nose and Throat Section

President: Dr. E. C. Moulton, 619 Garrison Ave., Fort Smith.
Secretary: Dr. K. W. Cosgrove, 7 Urquhart Bldg., Little Rock.

Colorado Ophthalmological Society

President: Dr. George H. Stine, Burns Bldg., Colorado Springs.
Secretary: Dr. J. Leonard Swigert, 320 Republic Bldg., Denver.
Place: Colorado General Hospital. Time: 7:30 p. m., third Saturday of each month, October to May, inclusive.

Connecticut State Medical Society, Section on Eye, Ear, Nose and Throat

President: Dr. W. H. Turnley, 1 Atlantic St., Stamford, Conn.
Secretary-Treasurer: Dr. Morton B. Arnold, 781 Main St., Williamantic, Conn.

Eye, Ear, Nose and Throat Club of Georgia

President: Dr. William O. Martin Jr., Doctors Bldg., Atlanta.
Secretary-Treasurer: Dr. C. K. McLaughlin, 666 Cherry St., Macon.

Indiana Academy of Ophthalmology and Oto-Laryngology

President: Dr. W. E. Stewart, 721 Wabash Ave., Terre Haute.
Secretary: Dr. Russell A. Sage, 23 E. Ohio St., Indianapolis.

Iowa Academy of Ophthalmology and Oto-Laryngology

President: Dr. C. S. O'Brien, University Hospital, Iowa City.
Secretary-Treasurer: Dr. Carl A. Noe, 120–3d Ave. S. E., Cedar Rapids.

Kansas State Medical Society, Section on Ophthalmology and Otolaryngology

President: Dr. W. B. Granger, Emporia.
Secretary: Dr. George F. Gsell, 911 Beacon Bldg., Wichita 2.

Louisiana-Mississippi Ophthalmological and Otolaryngological Society

President: Dr. George S. Adkins, 121 N. President St., Jackson, Miss.
Secretary-Treasurer: Dr. Edley H. Jones, 1301 Washington St., Vicksburg, Miss.

Medical Society of the State of Pennsylvania, Section on Eye, Ear, Nose and Throat Diseases

Chairman: Dr. William T. Hunt Jr., 1205 Spruce St., Philadelphia 7.
Secretary: Dr. Gabriel Tucker, 250 S. 18th St., Philadelphia 3.

Michigan State Medical Society, Section of Ophthalmology and Otolaryngology

Chairman: Dr. Ralph H. Gilbert, 110 Fulton St. E., Grand Rapids.
Secretary: Dr. Walter Z. Rundles, 620 Maxine Ave., Grand Rapids.
Place: Grand Rapids. Time: Sept. 23-26, 1947.

Minnesota Academy of Ophthalmology and Otolaryngology

President: Dr. L. R. Boies, 1427 Medical Arts Bldg., Minneapolis.
Secretary: Dr. W. L. Hoffman, 543 Medical Arts Bldg., Minneapolis.
Place: Minneapolis Club. Time: 6:00 p. m., second Friday of each month from October to May.

Montana Academy of Oto-Ophthalmology

President: Dr. H. Casebeer, 44 W. Park Ave., Butte.
Secretary: Dr. Fritz D. Hurd, 309 Medical Arts Bldg., Great Falls.

Nebraska Academy of Ophthalmology and Otolaryngology

President: Dr. W. Howard Morrison, 1500 Medical Arts Bldg., Omaha.
Secretary-Treasurer: Dr. John Peterson, 1307 N St., Lincoln.

New Jersey State Medical Society, Section on Ophthalmology, Otology and Rhinolaryngology

Chairman: Dr. C. W. Buvinger, 50 Washington St., East Orange.
Secretary: Dr. Z. Laurence Griesemer, 1145 E. Jersey St., Elizabeth.

New York State Medical Society, Eye, Ear, Nose and Throat Section

Chairman: Dr. Maxwell D. Ryan, 660 Madison Ave., New York 21.
Secretary: Dr. Thomas H. Johnson, 30 W. 59th St., New York.

North Carolina Eye, Ear, Nose and Throat Society

President: Dr. V. K. Hart, 106 W. 7th St., Charlotte.
Secretary: Dr. J. A. Harrill, Bowman Gray School of Medicine, Winston-Salem.
Place: Hendersonville. Time: Sept. 15-18, 1947.

North Dakota Academy of Ophthalmology and Oto-Laryngology

President: Dr. E. D. Perrin, 221–5th St., Bismarck.
Secretary-Treasurer: Dr. M. T. Lampert, Minot.

Oregon Academy of Ophthalmology and Oto-Laryngology

President: Dr. Wilfred Belnap, 833 S. W. 11th Ave., Portland.
Secretary-Treasurer: Dr. C. W. Kuhn, 1020 S. W. Taylor St., Portland 5.
Place: Good Samaritan Hospital, Portland. Time: Third Tuesday of each month.

Pennsylvania Academy of Ophthalmology and Otolaryngology

President: Dr. Gilbert L. Dailey, Harrisburg.
Secretary: Dr. Benjamin F. Souders, 143 N. 6th St., Reading.
Time: Last week in April.

Rhode Island Ophthalmological and Otological Society

Acting President: Dr. N. Darrell Harvey, 112 Waterman St., Providence.
Secretary-Treasurer: Dr. Linley C. Happ, 124 Waterman St., Providence.
Place: Rhode Island Medical Society, Library, Providence. Time: 8:30 p. m., second Thursday in October, December, February and April.

South Carolina Society of Ophthalmology and Otolaryngology

President: Dr. Ruskin Anderson, 145 N. Converse St., Spartanburg.
Secretary-Treasurer: Dr. Roderick Macdonald, 330 E. Main St., Rock Hill.
Place: Hendersonville. Time: September, 1947.

Tennessee Academy of Ophthalmology and Otolaryngology

President: Dr. George Burchfield, Maryville.
Secretary-Treasurer: Dr. Sam H. Sanders, 1089 Madison Ave., Memphis.

Texas Ophthalmological and Oto-Laryngological Society

President: Dr. W. E. Vandevere, 1001 First National Bank Bldg., El Paso.
Secretary: Dr. E. D. Dumas, 425 Medical Arts Bldg., San Antonio.
Place: Houston. Time: December, 1947.

Utah Ophthalmological Society

President: Dr. Charles Ruggeri Jr., 1120 Boston Bldg., Salt Lake City 1.
Secretary-Treasurer: Dr. Robert G. Snow, 202 E. South Temple, Salt Lake City 2.
Place: University Club, Salt Lake City. Time: 7:00 p. m., third Monday of each month, September through May.

Virginia Society of Oto-Laryngology and Ophthalmology

President: Dr. Thomas E. Hughes, 1000 W. Grace St., Richmond.
Secretary-Treasurer: Dr. Francis H. McGovern, 105 S. Union St., Danville.

West Virginia State Medical Association, Eye, Ear, Nose and Throat Section

President: Dr. George Traugh, 309 Cleveland Ave., Fairmont.
Secretary: Dr. Welch England, 621½ Market St., Parkersburg.

LOCAL

Akron Academy of Ophthalmology and Otolaryngology

President: Dr. R. F. Thaw, 301 Ohio Bldg., Akron, Ohio.
Secretary-Treasurer: Dr. J. C. Damitz, 2d National Bank Bldg., Akron 8, Ohio.
Time: 6:30 p. m., first Monday in January, March, May and November.

Atlanta Eye, Ear, Nose and Throat Society

President: Dr. William B. Armstrong, 478 Peachtree St. N. E., Atlanta, Ga.
Secretary: Dr. Lester A. Brown, 815 Doctors Bldg., Atlanta, Ga.
Place: Academy of Medicine. Time: 7:00 p. m., fourth Monday of each month from October to May.

Baltimore Medical Society, Section on Ophthalmology

Chairman: Dr. Cecil H. Bagley, 2 E. Reed St., Baltimore.
Secretary: Dr. F. Edwin Knowles Jr., 513 N. Charles St., Baltimore.
Place: Medical and Chirurgical Faculty, 1211 Cathedral St. Time: 8:30 p. m., fourth Thursday of each month from October to March.

Birmingham Eye, Ear, Nose and Throat Club

President: Each member, in alphabetical order.
Secretary: Dr. W. Chunn Parsons, 425 Woodward Bldg., Birmingham, Ala.
Place: Thomas Jefferson Hotel. Time: 6:30 p. m., second Tuesday of each month, September to May, inclusive.

Brooklyn Ophthalmological Society

President: Dr. Benjamin C. Rosenthal, 140 New York Ave., Brooklyn 16.
Secretary-Treasurer: Dr. Louis Freimark, 256 Rochester Ave., Brooklyn 13.
Place: Towers Hotel, 25 Clark St. Time: 8:15 p. m., third Thursday in February, April, October and December.

Buffalo Ophthalmologic Club

President: Dr. William H. Howard, 389 Linwood Ave., Buffalo 9.
Secretary-Treasurer: Dr. Sheldon B. Freeman, 196 Linwood Ave., Buffalo 9.
Time: Second Thursday of each month from October to May.

Central New York Eye, Ear, Nose and Throat Society

President: Dr. Uri Doolittle, University Bldg., Syracuse.
Secretary-Treasurer: Dr. Alfred W. Doust, 306 State Tower Bldg., Syracuse.
Place: University Club. Time: 7:00 p. m., second Wednesday.

Chattanooga Society of Ophthalmology and Otolaryngology

President: Each member, in alphabetical order.
Secretary: Dr. Douglas Chamberlain, Providence Bldg., Chattanooga, Tenn.
Place: Mountain City Club. Time: Second Thursday of each month from September to May.

Chicago Ophthalmological Society

President: Dr. W. A. Mann, 30 N. Michigan Ave., Chicago 2.
Secretary: Dr. J. R. Fitzgerald, 30 N. Michigan Ave., Chicago 2.
Place: Continental Hotel, 505 N. Michigan Ave. Time: Third Monday of each month from October to May.

Cincinnati General Hospital Ophthalmology Staff

Chairman: Rotate alphabetically.
Secretary: Dr. A. A. Levin, 441 Vine St., Cincinnati.
Place: Cincinnati General Hospital. Time: 7:45 p. m., third Friday of each month except June, July and August.

Cleveland Ophthalmological Club

Chairman: Dr. M. Paul Motto, Rose Bldg., Cleveland.
Secretary: Dr. H. H. Wygand, 624 Guardian Bldg., Cleveland.
Time: Second Tuesday in October, December, February and April.

College of Physicians, Philadelphia, Section on Ophthalmology

Chairman: Dr. Burton Chance, 317 S. 15th St., Philadelphia.
Clerk: Dr. George F. J. Kelly, 37 S. 20th St., Philadelphia.
Place: College of Physicians Bldg. Time: 8:15 p. m., third Thursday of every month from October to April, inclusive.

Columbus Ophthalmological and Oto-Laryngological Society

Chairman: Dr. M. Goldberg, 328 E. State St., Columbus, Ohio.
Secretary-Treasurer: Dr. W. J. Miller, 21 E. State St., Columbus, Ohio.
Place: University Club. Time: 6:15 p. m., first Monday of each month, from October to May, inclusive.

Corpus Christi Eye, Ear, Nose and Throat Society

Chairman: Dr. Edgar Mathis, 815 Medical Professional Bldg., Corpus Christi, Texas.
Secretary: Dr. June Yates, 210 Medical Professional Bldg., Corpus Christi, Texas.
Place: Nueces Hotel. Time: 6:30 p. m., third Tuesday of each month from October to May.

Dallas Academy of Ophthalmology and Oto-Laryngology

President: Dr. L. Darrough, 4105 Live Oak St., Dallas, Texas.
Secretary: Dr. C. A. Hoefer, 1719 Pacific Ave., Dallas 1, Texas.
Place: Dallas Athletic Club. Time: 6:30 p. m., first Tuesday of each month from October to June. The November, January and March meetings are devoted to clinical work.

Des Moines Academy of Ophthalmology and Otolaryngology

President: Dr. H. I. McPherrin, 406–6th Ave., Des Moines, Iowa.
Secretary-Treasurer: Dr. C. C. Jones, 1110 Equitable Bldg., Des Moines, Iowa.
Time: 6:30 p. m., fourth Monday of every month from September to May.

Detroit Ophthalmological Club

Chairman: Members rotate alphabetically.
Secretary: Dr. Wesley G. Reid, 974 Fisher Bldg., Detroit 2.
Place: Club rooms of Wayne County Medical Society. Time: Second Monday of each month, November to April, inclusive.

Detroit Ophthalmological Society

President: Dr. Bruce Fralick, 201 S. Main St., Ann Arbor, Mich.
Secretary: Dr. William S. Gonne, 619 David Whitney Bldg., Detroit 26.
Place: Hayler's L'Aiglon Bldg. Time: 6:30 p. m., third Thursday of each month from November to April, inclusive.

Eastern New York Eye, Ear, Nose and Throat Association

President: Dr. Frank C. Furlong, 713 Union St., Schenectady.
Secretary-Treasurer: Dr. E. Martin Freund, 762 Madison Ave., Albany.
Time: Third Wednesday in October, November, March, April, May and June.

Fort Worth Eye, Ear, Nose and Throat Society

President: Dr. C. R. Lees, 602 W. 10th St., Fort Worth 2, Texas.
Secretary-Treasurer: Dr. Van D. Rathgeber, 1305 Medical Arts Bldg., Fort Worth, Texas.
Place: Tarrant County Medical Hall, Medical Arts Bldg. Time: 7:30 p. m., first Friday of each month except July and August.

Houston Academy of Medicine, Ophthalmological and Oto-Laryngological Section

President: Dr. J. Matt Robison, 1304 Walker Ave., Houston, Texas.
Secretary: Dr. John H. Barrett, 1304 Walker Ave., Houston, Texas.
Place: River Oaks Country Club. Time: 6:30 p. m., second Thursday of each month from October to June.

Indianapolis Ophthalmological and Otolaryngological Society

President: Dr. J. Jerome Littell, 603 Hume Mansur Bldg., Indianapolis.
Secretary: Dr. J. Lawrence Sims, 23 E. Ohio St., Indianapolis.
Place: Indianapolis Athletic Club. Time: 6:30 p. m., second Thursday of each month from November to May.

Kansas City Society of Ophthalmology and Oto-Laryngology

President: Dr. Walter L. Small, 1103 Grand Ave., Kansas City, Mo.
Secretary: Dr. John Clair Howard Jr., 1103 Grand Ave., Kansas City, Mo.
Time: Third Thursday of each month from October to June. The November, January and March meetings are devoted to clinical work.

Long Beach Eye, Ear, Nose and Throat Society

Chairman: Dr. Robert G. Thornburgh, 117 E. 8th St., Long Beach 2, Calif.
Secretary-Treasurer: Dr. Kirt Parks, 605 Professional Bldg., Long Beach 2, Calif.
Place: Seaside Hospital. Time: Third Wednesday of each month from October to May.

Los Angeles Society of Ophthalmology and Otolaryngology

President: Dr. William D. Donoher, Los Angeles.
Secretary-Treasurer: Dr. K. C. Brandenburg, 110 Pine Ave., Long Beach 2, Calif.
Place: Los Angeles County Medical Association Bldg., 1925 Wilshire Blvd. Time: 6:00 p. m., fourth Monday of each month from September to May, inclusive.

Louisville Eye and Ear Society

President: Dr. Joseph S. Heitger, Heyburn Bldg., Louisville, Ky.
Secretary-Treasurer: Dr. J. W. Fish, 321 W. Broadway, Louisville, Ky.
Place: Brown Hotel. Time: 6:30 p. m., second Thursday of each month from September to May, inclusive.

Lower Anthracite Eye, Ear, Nose and Throat Society

Chairman: Each member in alphabetical order.
Secretary: Dr. James J. Monohan, 31 S. Jardin St., Shenandoah, Pa.

Medical Society of the District of Columbia, Section of Ophthalmology and Otolaryngology

Chairman: Dr. P. S. Constantinople, 1835 I St. N. W., Washington.
Secretary: Dr. Frazier Williams, 1801 I St. N. W., Washington.
Place: 1718 M St. N. W. Time: 8 p. m., third Friday of each month from October to April, inclusive.

Memphis Society of Ophthalmology and Otolaryngology

Chairman: Each member, in alphabetical order.
Secretary: Dr. Sam H. Sanders, 1089 Madison Ave., Memphis, Tenn.
Place: Eye Clinic of Memphis Eye, Ear, Nose and Throat Hospital. Time: 8 p. m., second Tuesday of each month from September to May.

Milwaukee Oto-Ophthalmic Society

President: Dr. Meyer S. Fox, 238 W. Wisconsin Ave., Milwaukee.
Secretary-Treasurer: Dr. Ralph T. Rank, 238 W. Wisconsin Ave., Milwaukee.
Place: University Club. Time: 6:30 p. m., fourth Tuesday of each month from October to May.

Montgomery County Medical Society

Chairman: Dr. H. V. Dutrow, 1040 Fidelity Medical Bldg., Dayton, Ohio.
Secretary-Treasurer: Dr. Maitland D. Place, 981 Reibold Bldg., Dayton, Ohio.
Place: Van Cleve Hotel: Time: 6:30 p. m., first Tuesday of each month from October to June, inclusive.

Montreal Ophthalmological Society

President: Dr. L. F. Badeaux, 502 Cherrier St., Montreal, Canada.
Secretary: Dr. John V. V. Nicholls, 1414 Drummond St., Montreal, Canada.
Time: Second Thursday of October, December, February and April.

Nashville Academy of Ophthalmology and Otolaryngology

Chairman: Dr. M. M. Cullom, 700 Church St., Nashville, Tenn.
Secretary: Dr. R. E. Sullivan, 432 Doctors Bldg., Nashville 3, Tenn.
Place: James Robertson Hotel. Time: 6:30 p. m., third Monday of each month from October to May.

New Orleans Ophthalmological and Otolaryngological Society

President: Dr. Charles A. Bahn, Maison Blanche Bldg., New Orleans.
Secretary: Dr. Mercer G. Lynch, Ochsner Clinic, New Orleans.
Place: Charity Hospital. Time: 8 p. m., first Tuesday of every month.

New York Academy of Medicine, Section of Ophthalmology

Chairman: Dr. Guernsey Frey, New York.
Secretary: Dr. Maynard Wheeler, 30 W. 59th St., New York.
Time: 8:30 p. m., third Monday of every month from October to May, inclusive.

New York Society for Clinical Ophthalmology

President: Dr. Daniel Kravitz, 861 Park Pl., Brooklyn.
Secretary: Dr. Leon Ehrlich, 211 Central Park W., New York.
Place: New York Academy of Medicine, 2 E. 103d St. Time: 8 p. m., first Monday of each month from October to May, inclusive.

Oklahoma City Academy of Ophthalmology and Otolaryngology

President: Dr. S. R. Shaver, 117 N. Broadway, Oklahoma City.
Secretary: Dr. William Mussil, Medical Arts Bldg., Oklahoma City.
Place: University Hospital. Time: Second Tuesday of each month from September to May.

Omaha and Council Bluffs Ophthalmological and Oto-Laryngological Society

President: Dr. Lyman H. Heine, Fremont, Neb.
Secretary-Treasurer: Dr. W. Howard Morrison, 1500 Medical Arts Bldg., Omaha 2.
Place: Omaha Club, 20th and Douglas Sts., Omaha. Time: 6 p. m. dinner; 7 p. m. program; third Wednesday of each month from October to May.

Passaic-Bergen Ophthalmological Club

President: Dr. Thomas Sanfacon, 340 Park Ave., Paterson, N. J.
Secretary-Treasurer: Dr. J. Averbach, 435 Clifton Ave., Clifton, N. J.
Place: Doctors Lounge, Paulsen Medical and Dental Bldg. Time: 8 p. m., last Tuesday of each month except June, July and August.

Philadelphia County Medical Society, Eye Section

President: Dr. L. Waller Deichler, 1930 Chestnut St., Philadelphia 3.
Secretary: Dr. Robert T. M. Donnelly, 255 S. 17th St., Philadelphia.
Time: First Thursday of each month from October to May.

Pittsburgh Ophthalmological Society

President: Dr. Jay G. Linn, Jenkins Arcade, Pittsburgh.
Secretary: Dr. Robert J. Billings, Jenkins Arcade, Pittsburgh.
Place: Pittsburgh Academy of Medicine Bldg. Time: Fourth Monday of each month, except June, July, August and September.

Reading Eye, Ear, Nose and Throat Society

President: Dr. Claude W. Bankes, 212 N. 6th St., Reading, Pa.
Secretary: Dr. Paul C. Craig, 232 N. 5th St., Reading, Pa.
Place: Wyomissing Club. Time: 6:30 p. m., third Wednesday of each month from September to July.

Richmond Eye, Ear, Nose and Throat Society

President: Dr. Edgar Childrey Jr., Professional Bldg., Richmond, Va.
Secretary: Dr. Clifford A. Folkes, Professional Bldg., Richmond, Va.
Place: Commonwealth Club. Time: 6 p. m., first Tuesday of January, March, May and October.

Rochester Eye, Ear, Nose and Throat Society

President: Dr. Frank Barber, 75 S. Fitzhugh St., Rochester, N. Y.
Secretary-Treasurer: Dr. Charles T. Sullivan, 277 Alexander St., Rochester, N. Y.

St. Louis Ophthalmic Society

President: Dr. A. Lange, 3903 Olive St., St. Louis.
Secretary: Dr. William Kleinberg, Frisco Bldg., St. Louis.
Place: McMillan Hospital. Time: Fourth Friday of each month from October to April, inclusive, except December, at 8:00 p. m.

San Antonio Ophthalmo-Oto-Laryngological Society

President: Dr. James P. Aderhold, Medical Arts Bldg., San Antonio, Texas.
Secretary-Treasurer: Dr. Virgil S. Steele, South Texas Bldg., San Antonio, Texas.
Place: San Antonio Texas, and Brooke General Hospital. Time: 7 p. m., second Tuesday of each month from September to May.

San Francisco County Medical Society, Section on Eye, Ear, Nose and Throat

Chairman: Dr. C. B. Cowan, 490 Post St., San Francisco.
Secretary: Dr. D. Harrington, 384 Post St., San Francisco.
Place: Society's Bldg., 2180 Washington St., San Francisco. Time: Fourth Tuesday of every month except June, July and December.

Shreveport Eye, Ear, Nose and Throat Society

President: Dr. David C. Swearingen, Slattery Bldg., Shreveport, La.
Secretary-Treasurer: Dr. Kenneth Jones, Medical Arts Bldg., Shreveport, La.
Place: Shreveport Charity Hospital. Time: 7:30 p. m., first Monday of every month except July, August and September.

Spokane Academy of Ophthalmology and Oto-Laryngology

President: Dr. Robert L. Pohl, 762 Paulsen Medical and Dental Bldg., Spokane, Wash.
Secretary: Dr. Malcolm N. Wilmes, 960 Paulsen Medical and Dental Bldg., Spokane, Wash.
Place: Doctors Lounge, Paulsen Medical and Dental Bldg. Time: 8 p. m., last Tuesday of each month except June, July and August.

Syracuse Eye, Ear, Nose and Throat Society

President: Dr. A. H. Rubenstein, 713 E. Genesee St., Syracuse, N. Y.
Secretary-Treasurer: Dr. I. H. Blaisdell, 713 E. Genesee St., Syracuse, N. Y.
Place: University Club. Time: First Tuesday of each month except June, July and August.

Toledo Eye, Ear, Nose and Throat Society

Chairman: Dr. W. W. Randolph, 1838 Parkwood Ave., Toledo 2, Ohio.
Secretary: Dr. John L. Roberts, 316 Michigan St., Toledo, Ohio.
Place: Toledo Club. Time: 6:30 p. m., each month except June, July and August.

Toronto Academy of Medicine, Section of Ophthalmology

Chairman: Dr. R. G. C. Kelly, 14 Lynwood Ave., Toronto 5, Canada.
Secretary: Dr. J. C. McCulloch, 830 Medical Arts Bldg., Toronto 5, Canada.
Place: Academy of Medicine, 288 Bloor St. W. Time: First Monday of each month, November to April.

Washington, D. C., Ophthalmological Society

President: Dr. Richard W. Wilkinson, 1408 L St. N. W., Washington, D. C.
Secretary-Treasurer: Dr. Jerome A. Sansoucy, 2017 Massachusetts Ave. N. W., Washington, D. C.
Place: Medical Society of District of Columbia Bldg., 1718 M St. N. W., Washington, D. C. Time: 7:30 p. m., first Monday of each month from November to May.

Wilkes-Barre Ophthalmological Society

Chairman: Each member in turn.
Secretary: Dr. Samuel T. Buckman, 70 S. Franklin St., Wilkes-Barre, Pa.
Place: County Medical Society Library. Time: Last Tuesday of each month from October to May.